Annual Report of the

Board of Scientific Advice for India

for the year 1913-14

Calcutta
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1915

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4. The Director, Geological Survey of India.

ANNUAL REPORT FOR 1913-14

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

1913-14

SUMMARY OF PROCEEDINGS.

Twenty-sixth Meeting held at Simla on the 18th May 1914.

The programmes for 1914-15 of the various Scientific Departments were considered by the Board. It was resolved that all the programmes should be accepted with minor emendations in and additions to certain of them.

The question of preparation by the Asiatic Society of Bengal, with assistance from Government, of a Catalogue of Scientific periodicals available in libraries in India outside of Calcutta was discussed. The Board having been informed that the Asiatic Society of Bengal was co-operating with all the libraries of any importance in Calcutta in the scheme for drawing up a catalogue of the scientific periodicals available in Calcutta resolved that as valuable information regarding the preparation of catalogues is likely to accrue from work on the Calcutta catalogue, the preparation of a similar work for libraries throughout India might await the publication of the Calcutta catalogue.

The Board then considered a letter from the Government of India forwarding a suggestion by the Surveyor-General of India that observations of the amount of snow lying upon mountains and of the position

of the snow-line would be valuable in supplementing the observations of glaciers. The Board resolved that the question raised by the Surveyor-General was well worth investigation and that Sub-Committee A should be asked to report in what manner the necessary observations could best be carried out.

Twenty-seventh Meeting held at Delhi on 12th November 1914.

The report of the Sub-Committee referred to in the proceedings of the twenty-sixth meeting was submitted to the Board. The Sub-Committee were of opinion that if the amount of snow-fall and of the area under snow on the Himalayas could be measured systematically for different seasons of the year the results may be expected to throw light not merely on the question of the extent, if any, to which a gradual change is taking place either in the direction of increase or diminution in the accumulations of snow on the Himalayas, but also on several other problems. It was proposed that the Meteorological Department should continue to make systematic observations of snow-fall and snow depth and that the Survey of India should endeavour to determine the absolute height of the snow-line and the extent of the area under snow at different times of the year. The Geological Survey would continue observations of the movements of glaciers. The Board accepted the recommendations contained in the report of the Sub-Committee.

The draft Annual Report of the Board was then discussed. Subject to minor emendations and alterations in certain of the sections the draft was accepted as satisfactory by the Board.

APPLIED CHEMISTRY.

PART I.—AGRICULTURAL CHEMISTRY.

BY

J. WALTER LEATHER, V.D., Ph.D., F.I.C.,
Imperial Agricultural Chemist.

SOILS.

Soil survey—Tanjore Delta.—A very useful contribution to our knowledge of Indian soils has been issued by W. H. Harrison and Raghunathswami Ayyangar. During two tours through the Tanjore Delta in 1912 and 1913, 134 samples of soils were collected, and after subsequent visual examination at the laboratory, 92 were subjected to chemical analyses. The results of these analyses were then charted, and show in which parts of the Delta certain classes of manures are likely to prove worth their special cost. Thus the proportion of organic nitrogen is so low over the whole area that it is anticipated that organic nitrogenous manures will be generally beneficial, though there are certain difficulties in relation to their successful application. The soil of nearly the whole of the area is also deficient in readily available phosphate. The soils of the northern and eastern portions are probably in need of applications of lime. On the other hand there are only few places where potassic manures are apparently needed. Respecting physical conditions, certain portions of the Delta appear to be badly drained and are tending to become saline.

Acid soil—Assam.—During the past two years A. A. Meggitt has had a soil at Jorhat under observation and experiment which is strongly acid, is greatly deficient in lime, and is generally very infertile. Thus neither khariff nor rabi crops can mature, whilst the latter generally fail after germination.

Previous experiments had shown that applications of slaked lime corrected the inherent defects of the soil to such an extent that rabi crops generally matured very well. It remained to ascertain more thoroughly the nature of the defective state of the soil and its causes.

The investigation was conducted in part by means of small plots in the field and in part by water cultures in the laboratory.

For the former purpose, 26 plots were laid out, and a great variety of substances, some basic, others neutral or acid in character but having in general "manurial" values, were applied to the land. In addition,

one-half of each plot was treated with slaked lime. After suitable cultivation a crop of oats was sown over the whole area. The results obtained from this part of the work may be summarised as follows:—

(*a*) The effect of *slaked lime* was particularly marked. Whilst no crop at all was obtained from the land without this treatment, a very fairly good crop of oats matured where 30 maunds (about one ton) of lime had been applied. (*b*) Of other *basic* materials, *ground limestone, magnesium carbonate, sodium carbonate, potassium carbonate, basic slag* all produced a positive effect, and the oats matured (without caustic lime) though they were only one-half or one-third as heavy as where lime alone was used. These dressings were, however, not employed in quantity equal to the lime in neutralising power, which no doubt accounts at least in a measure for the difference. On the other half plots to which lime had also been added, the crops were as good or better than where lime alone was employed. (*c*) *Neutral* substances such as *sodium, potassium or calcium nitrate, potassium, ammonium or calcium sulphate, potassium or calcium chloride,* had no effect by themselves and where lime had been used in addition, the crop was frequently smaller than where the latter was alone employed, thus showing that some of them had a detrimental effect. A *finely ground phosphate* formed an exception. (*d*) Mixtures of manures such as *superphosphate* and *sodium nitrate* or *sulphate of ammonia* had but little effect, and *sulphate of ammonia* appeared to be generally harmful.

The laboratory experiments with water cultures, though only of a preliminary character, went to show that the soil contains a toxic substance which particularly affects the young roots of the seedling plant.

Magnesium carbonate and dolomite.—The solubility relations which exist between carbonic acid gas and magnesium carbonate in water, and the same when calcium carbonate is also present, have been worked out by J. W. Leather and Jatindranath Sen, and form a sequel to the investigation of the corresponding relation when calcium carbonate is the only salt present. The object in view was to endeavour to ascertain how much of these salts can be in solution in the soil-water. Magnesium carbonate dissolves in presence of water and carbonic acid to a bicarbonate which is very much more stable than the corresponding calcium salt, and is about ten times more soluble. Its solution contains practically no carbonic acid in excess of that required to form the bicarbonate, whereas the calcium salt demands for its existence a large excess. The second part of the present work dealt with the two bicarbonates when present together. It was to be expected from a consideration of the law of mass action, that calcium carbonate must become more or less precipitated from solution in the presence of much magnesium bicarbonate. This proved to be the case and the important conclusion is drawn that no fertile soil can contain much magnesium carbonate, for in that case, the calcium carbonate would become so far insoluble

as to cause "lime hunger" and consequent infertility. Generally speaking the magnesium of soils, which is not present as silicate or dolomite, will be combined with other acid radicals. It likewise becomes clear why, in experiments with magnesium carbonate as a "manure," frequently harmful effects have resulted.

Dolomite dissolves in carbonic acid as a double salt, so that the solution contains the bicarbonates of magnesium and calcium in equimolecular proportions. Since no large amount of calcium bicorbonate can exist in solution with magnesium bicarbonate, the solubility of dolomite is limited. It was also possible to forecast what would be the effect of the presence of either magnesium carbonate or calcium carbonate on its solubility. If magnesium carbonate is present with the dolomite, its solution prevents the co-presence of any appreciable amount of calcium bicarbonate, and consequently dolomite cannot dissolve. Experiment showed that it was practically insoluble under these conditions. If secondly calcium carbonate is present with dolomite, the former would rapidly form a solution of bicarbonate which is stronger than can exist in the presence of magnesium bicarbonate, and it also must prevent dolomite from going into solution. This part of the work offers a full explanation of the apparently contradictory observations of authorities regarding the weathering of dolomite and at the same time shows why dolomite may be safely used as a basic manure for land.

Gases of swamp rice soils.—W. H. Harrison and Subramania Ayyar have provided further information in respect of the functions of the surface film which forms in paddy lands.* It will be recollected that in their first communication they showed that a gaseous mixture consisting principally of methane, nitrogen, hydrogen and carbon dioxide is generated in the soil of swamp paddy lands, and that after the crop is planted out, a film forms over the soil surface, consisting largely of bacteria, algæ and diatoms, by which a gaseous mixture containing a high proportion of oxygen is formed.

In the present paper the authors detail experimental evidence regarding the functions of this film and which may be briefly summarised as follows:—*Methane* is assimilated as such and it is also oxidised to carbon dioxide, both changes being independent of light; the hydrogen is oxidised to water; carbon dioxide is assimilated, with liberation of half its oxygen in the gaseous state, and it also seems probable that some part of the carbon dioxide is simply assimilated without liberation of any gaseous oxygen. The bacteriological part of the work is to be published separately.

The function of the surface film in the field is thus to liberate oxygen. The process requires in fact an additional supply of oxygen for its completion, and this the authors consider is derived from the dissolved oxygen of the irrigation water, which, partly because of the extensive surface

* See Ann. Rep Bd. Sci. Adv., 1912-13, p. 14.

which is exposed to the outside air and partly owing to its constant circulation, brings to the film a supply of the gas which is far in excess of its requirements.

MINERAL SALTS.

The system potassium nitrate, sodium chloride, water.—The amounts of the two salts, potassium nitrate and sodium chloride which may dissolve together in a given amount of water, has only hitherto been known for one or two specified temperatures, and even for these the information was incomplete. It was desired, for the assistance of some work on saltpetre refining, to possess more accurate information on this subject; and the composition of the solution when one or other of these salts is in excess, as also the corresponding information regarding the four simpler systems, in each of which only one positive or negative is present, has been worked out by J. W. Leather and Jatindra Nath Mukerji for temperatures varying between 20° and 91° C. Regarding the subsidiary systems, the effect of one nitrate on the other is to increase its solubility; but in all other cases the effect of one salt on the other is to reduce its solubility, though in very varying degree. For example, the presence of excess of potassium chloride reduces the solubility of potassium nitrate to about one-half; whilst potassium nitrate in excess reduces the solubility of potassium chloride by about one-tenth.

When potassium nitrate and sodium chloride are present together in excess of what will dissolve in the water, a third salt, either potassium chloride or sodium nitrate, forms to a limited extent in the solution; below about 30° C. the salt is potassium chloride, whilst above that temperature it is sodium nitrate. At the same time an equivalent amount of sodium nitrate or potassium chloride respectively is precipitated in the solid state.

SUGAR.

Sugarcane-crushing.—Experiments have been in progress at the Partabgarh and Shahjehanpur experiment stations during the past three years on the efficiency of the small iron bullock-power mill which is employed in one size or another practically throughout India for crushing sugarcane, and a note on the data obtained has been recently contributed by G. Clarke and S. C. Banerjee. The efficiency of a sugarcane mill is the resultant of several factors; but that which the authors had chiefly under examination was the proportion of the total sugar in the cane which was expressed as juice by the mill.

If a known weight of cane is crushed, the juice and the bagasse can be weighed, the sugar determined in each, and from these quantities the proportion of the total sugar of the cane, which is in the juice, ascertained. Putting the total sugar = 100, the "extraction" or "extraction

coefficient" is that portion of the total sugar which is in the expressed juice. The best type of 8″ three-roller mill which is on the market was employed for most of the work, which had to do with varieties of cane grown at the experimental stations. In comparison with this, certain tests were made with a mill from a village worked by a cultivator with his own bullocks. When the cane was crushed in the experiment station mill, the "extraction" was found to vary among the varieties of cane tested, from 87 to 71, and the authors remark that "an exceedingly high order of extraction was obtained,......................The cost of crushing is an entirely different matter. The slow rate at which cane can be crushed, and the large amount of bullock-power required, makes the cost of crushing high. It is doubtful for single dry crushing if any type of mill will extract a larger proportion of sugar, but the cost of crushing can be probably lowered by the use of some other form of power,......... ...." The weight of cane crushed varied from 120 to 150 lbs. per mill per hour, using 4 bullocks per mill. The extraction was 81. In two experiments, when a cultivator crushed 10 maunds of cane in a village mill with his own 4 bullocks, 150 lbs. cane was crushed per hour. The extraction was 75. Thus here the defect in efficiency seems to have been chiefly in extraction.

Sugarcane-fibre.—The proportions of fibre in varieties of sugarcane have been examined by C. Somers Taylor at Sabour. Some forty varieties were examined and the percentage fibre in the cane and in the megass was determined. These percentages varied from 8 to 16, and there is some reason for believing that the proportion of the fibre is fairly constant for any one variety, and that if canes, supposed to be of one variety, prove on examination to contain markedly different proportions of fibre, they are probably of two or more varieties. Thus in one case, four plots of a cane called *Chinya* were grown from four distinct single plants, and the percentage fibre in the cane was found to be 11·36, 12·01, 15·67, 15·13, respectively. If the proportion of fibre is a definite character, these plots consisted not of one but probably of two varieties, a supposition which was supported by the subsequent botanical examination. From the manufacturing point of view, a low percentage of fibre is an important advantage because the cost of crushing cane is thereby reduced, but Mr. Taylor points out that canes which possess a very low percentage of fibre are frequently delicate and susceptible to attacks of pests.

Ripening of sugarcane—effect of manure.—A series of experiments were made by C. S. Taylor at the Sabour Experiment Station in 1912-13 on the effect of certain manures on the period of ripening of sugarcane, which showed that ammonium sulphate, 2 maunds per acre, delays the ripening of cane for perhaps a fortnight. During November and December the crop was not so mature where ammonium sulphate was used, and until the middle of January this cane contained less sucrose and very appreciably more glucose, but by mid-February it had matured

and was equal in quality to the cane where no ammonium sulphate had been used.

A very important fact in relation to Mr. Taylor's work is that he included no fewer than six plots to which no special manures were added and by their aid was able to show in how far the land was uniform from plot to plot; and where ammonium sulphate was employed there were three plots which were so nearly alike in treatment that they could be considered as one group. Thus, although only one variety of cane was grown and the experiment was made during only one year, the result possesses a much greater degree of reliability than can frequently be allowed to this class of work.

Sugarcane—Punjab.—During the past two seasons the sugarcane of the Gurdaspur District, as also cane grown at the Government Experimental Farms, Gurdaspur and Lyallpur, have been examined by J. H. Barnes. The canes grown in the district include principally five varieties, three of these being those chiefly crushed for *gur* making. The following data give a general idea of the quality of these canes: juice expressed by bullock-power mill 50 to 60 per cent., sucrose in juice 15 to 17 per cent., glucose ·25 to 1·00 per cent., fibre 15 to 20 per cent., coefficient of purity 70 to 90. That is, they are very fibrous canes, containing a juice with good sucrose percentage but rather low purity. Frost frequently occurs in January and this detrimentally affects the cane. The locally made *gur* contains from 65 to 75 per cent. sucrose, 10 to 20 per cent. glucose.

Sugar beet.—The Annual Report of the Agricultural Station at Tarnab contains information regarding the quality of the sugar beet crops which are being grown there. These were analysed first in 1912 at Pusa, when some of the roots were found to be very rich and contained upwards of 20 per cent. sucrose. In 1913 a more complete set of analyses were made by the Imperial Agricultural Chemist at Tarnab. About twenty individual roots were analysed and these contained from 9 per cent. to 19 per cent. sucrose, ·1 per cent. or less of glucose, and from 4 per cent. to 8 per cent. fibre. Average samples (100 roots each) from plots sown in the previous October and November were found to contain 14·7 per cent. and 14·2 per cent. sucrose, ·07 per cent. glucose and 6·9 per cent. and 6·7 per cent. fibre respectively. They were thus up to a very fair European average.

Sweet jowar (Sorghum sp.).—Some plots of sweet jowar were grown at Lyallpur and Gurdaspur in 1912 and the juice and *gur* analysed by H. E. Annett. It was found that when the crop was coming into flower the proportion of sugars was quite low; as it ripened and the seed commenced to dry, the sucrose had risen to 10 per cent. in the juice, the invert sugars were about 2 per cent. and the amount of juice expressed was about 40 per cent. The *gur* made contained 58 per cent. sucrose and 13 per cent. glucose.

Thus, as a source of manufactured sugar this plant is useless, but as a fodder it should stand very high.

RICE.

Rices—their differentiation.—Two contributions have been made during the year by F. J. Warth and D. B. Darabsett on the chemical differentiation of rices; the one deals with the disintegration of the grain by dilute alkali, and the other with the fractional liquefaction of the starch.

It was found that if the rice grain is carefully polished with emery cloth until the tegumen is removed, the action of dilute, 1·0 per cent. up to 2·0 per cent. potassium hydroxide, on the grain at room temperature was sufficiently constant to admit of chemical differentiation among varieties of paddy, which method may prove of value from the miller's standpoint. Some rices when treated in this way swell up, disintegrate and gelatinise very much more rapidly than others.

Similarly, if the polished rice is treated with 1·0 per cent. potassium hydroxide solution for 24 hours, then gently ground in a mortar with successive small quantities of water, the liquid neutralised and treated with malt extract for a specified time at specified temperature, and the hydrolised starch (and other carbohydrates) determined, rices can be differentiated, which no ordinary chemical analysis would separate.

Judging by the published data, the two processes yield very similar results; that is, a rice which is resistant to the action of dilute potash, yields a low proportion of hydrolised carbohydrate when acted upon by malt extract, which is what might be more or less anticipated.

Paddy mill products.—An interesting series of chemical analyses of the products of rice milling has been made by F. J. Warth and D. B. Darabsett. The list includes paddy, broken rices, loonzein, polished rice, rice meals, dust and husk, and forms the most complete information that we have on this subject.

The meals and broken rice are, chemically, the best foods, and the polished rice contains less oil, proteids, and phosphorus. Consequently one is apt to condemn the polishing process. But the consumer holds that one cannot cook unpolished rice, which concludes the argument! It follows that rice should be consumed in conjunction with other grain, particularly pulses, which indeed is very commonly the case.

MILK.

Milk of Montgomery cows and errors in milk records.—Records of the yield of milk and its composition are generally subject to errors in the dairy which are large compared with those in the laboratory. Some of these are well recognised, as for example the effect of food, the

period of lactation, period elapsing between milkings and the like. Where, as in India, the cow commonly demands that her calf shall suck at the same time as the udder is hand-milked, a further large source of error is introduced. A series of records of yield and composition of the milk of the Montgomery (Saniwal) herd, which is maintained at Pusa, has recently been kept by J. W. Leather and A. C. Dobbs and the numerical value of the errors accompanying such records has been examined and discussed.

The records had in view (*i*) the daily total yield or production of milk of twenty-five selected cows, divided into three groups, when in full milk or fairly full milk, and (*ii*) the composition of the milk. They extended over about two months for each group. The errors due to period of lactation and variation of food were not considered; these conditions being approximately constant for any one group. The error due to length of time elapsing between milkings was eliminated by making these equal, namely, 12 hours each. The error due to the calf sucking at the same time as the cow was hand-milked was eliminated by allowing the calf to take milk from one half-udder whilst the other half was hand-milked. Prior to the trials there was some doubt as to whether the milk would be drawn equally efficiently by the calf and the man respectively, and in order to ascertain whether this was so or not, the one half-udder was hand-milked for one 24 hours, then the other half for the succeeding 24 hours, this sequence being continued throughout the period; also in order to eliminate the effect of any inequality of milk secretion during the day and night respectively, the change for either half-udder from hand-milking to the calf-sucking was made for one half period in the morning, for the other half period in the evening.

The data admitted of the following deductions:—

(*a*) *The daily production of milk* varied among individuals from 6·4 to 21·5 lbs., but the yield of most of the cows lay between 10 and 14 lbs.

(*b*) The *yield* of milk *morning* and *evening* was for all cows equal; what differences occurred were less than the probable error and were not systematic.

(*c*) The *yield* from the *two sides of the udder* was in most cases equal; but five cows yielded systematically more from one half than from the other.

(*d*) The probable error of a *single milking* was about $\pm$·28, and emphasises the desirability of conducting such tests over a considerable period if reasonable accuracy is to be attained. For the Pusa records the mean yield for either side of the udder or for morning and evening was derived from 10 to 15 milkings, and the probable error was then less than $\pm$·1;

the probability that these means were within ·3 lb. of the truth was 99 : 1.

(*e*) The *mean percentage of fat* in the milk of individuals varied from 3·5 to 5·0.

(*f*) The milk of *different sides* of the udder contained approximately equal percentage fat; only one cow showed a systematic difference in this respect. The milk from *different quarters* of the udder showed systematic differences in the case of two cows out of three which were examined in this respect.

(*g*) The percentage of fat in the *morning* and *evening* milk respectively showed a very systematic difference, that of the morning being *always* the richer; the differences among the mean percentages varied from ·3 to 1·7; the mean figure was ·91 percentage fat in favour of the morning milk. This is an unusual result; in England the morning milk is only slightly richer than the evening when the two periods between milkings are equal.

(*h*) The *solids-not-fat* in those milks was found to be normal.

(*i*) When *milked in the ordinary way* as for profit, when the calf is given as little as possible, the probable error rose to about three times what it was when the calf was allowed the milk of one-half the udder; that is, under these conditions not only is the real production of milk unknown, but also the error per milking is three times as great.

List of Publications.

ANNETT, H. E. . . The use of Sweet Jowar (Sorghum Sp.) as a source of Commercial Sugar or as fodder and the variation in composition of the crop during growth. (*Agric. Research Inst., Bull. No. 41.*)

BARNES, J. H. . . Sugarcane in the Gurdaspore District, 1911-12; Progress Report for 1913 on Sugar in the Punjab.

CLARKE, G., & BANERJEE, S. C. Notes on Cane Crushing in the United Provinces. (*Agric. Research Inst., Bull. No. 42.*)

HARRISON, W. H., & RAGHUNATHSWAMI AYYANGAR. A Soil Survey of the Tanjore Delta. (*Madras Agric. Dept., Bull. No. 68, iii.*)

HARRISON, W. H., & SUBRAMANIA AYYAR. The Utilization of the Gases of Swamp Rice Soils for the aeration of the roots of the crop. (*Mem. Dept. Agric. India, Chem. Series, iv, No. 1.*)

LEATHER, J. W., & DOBBS, A. C. — The Yield and Composition of the Milk of the Montgomery herd at Pusa and Errors in Milk Tests. (*Mem. Dept. Agric. India, Chem. Series, iii, No. 6.*)

LEATHER, J. W., & MUKERJEE, J. N. — The system Potassium Nitrate, Sodium Chloride, Water. (*Mem. Dept. Agric. India, Chem. Series, iii, No. 7.*)

LEATHER, J. W., & SEN, J. — The Systems (A) Water, Magnesium Carbonate and Carbonic Acid, (B) Water, Calcium Carbonate, Magnesium Carbonate and Carbonic Acid. (*Mem. Dept. Agric. India, Chem. Series, iii, No. 8.*)

MEGGITT, A. A. . Studies of an Acid Soil in Assam. (*Mem. Dept. Agric. India, Chem. Series, iii, No. 9.*)

TAYLOR, C. S. . . Notes on Experiments with Sugarcane at Sabour. (*Agric. Research Inst., Bull. No. 37.*)

WARTH, F. J., & DARABSETT, D. B. — Disintegration of Rice Grains by means of Alkali. (*Agric. Research Inst., Bull. No. 38.*)

WARTH, F. J., & DARABSETT, D. B. — The Fractional Liquefaction of Rice Starch. (*Mem. Dept. Agric. India, Chem. Series, iii, No. 5.*)

WARTH, F. J., & DARABSETT, D. B. — The Chemical Composition of Paddy Mill Products. (*Burma Dept. Agric., Bull. No. 10.*)

PART II.—FOREST CHEMISTRY.

BY

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The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year under report:—

Minor products obtained from Deodar, their value and uses.—Dry distillation of Deodar waste wood could not be taken up for want of necessary apparatus. But "Deodar oil" was distilled out of sawdust at Delhi in a large still by means of steam at a pressure of 40—50 lbs. Samples were sent through the Forest Economist to the Imperial Institute, London, Messrs. Schimmel & Co., Leipzig, and to the Veterinary Department, India, with a view to ascertaining the possible uses and market value of this oil. Reports are awaited.

The constants of the oil as determined at Dehra are given below. The oil consists mostly of sesquiterpenes. It has a reputation in India as a good antiseptic and healing oil for ulcers and wounds of cattle. If this is confirmed by actual experiments which are in hand, it is hoped that the distillation of this oil for medicinal purposes will be a profitable industry.

The constants of the oil are:—

Specific gravity at 20° C.	0·949
Angle of rotation in 100 mm. tube	−33·1°
Acid number	3·01
Saponification value	25·85
Ester number	22·84
Iodine value (Hubl. 18 hours)	237·30

Fractions:—

	Per cent.
Passing up to 250° C.	23·3
„ „ 250—270° C.	71·3
Residue above 270° C.	5·4

The specific gravity and optical rotation of the two fractions are:—

(1) Specific gravity at 20° C.	(1) 0·942, (2) 0·948
(2) Optical rotation in 100 mm. tube	(1) −35·6°, (2) 36·6°

This enquiry will be continued.

Enquiry as to the possibility of reducing the harshness of certain tan barks.—This enquiry has been completed and the report embodying the results of the enquiry is under preparation. It has been found possible to reduce the harshness of certain tannin extracts by adding 10 per cent. of fat or oil calculated on the tannin content of the tan liquor.

The manufacture of products from *Boswellia serrata* and their chemical composition.—Preliminary experiments on *Boswellia* gum resin were completed during the year. The oleoresin was steam-distilled. The oil obtained was redistilled dividing it into two portions.

The first portion gave the following constants:—

Specific gravity at 22° C.	·8371
Angle of rotation in 100 mm. tube	+32·5°

Fractions:—

	Per cent.
Passing up to 155° C.	87
„ „ 155—160° C.	8
Above 160° C.	5

It consists almost wholly of dextro-pinene. A sample has been sent to the Imperial Institute, London, for valuation.

The second portion consisting mostly of limonene or dipentene has also been sent to the Imperial Institute to get an idea of its industrial uses and price.

The resins left behind in the still after distilling off the oil described above were worked into two different products, (1) "Boswellia-rosin" and (2) "Boswellia-wax."

"Boswellia-rosin" is the product obtained by drying off the residual resins of the still in open air over a bath of hot air.

Its constants are as follows:—

Specific gravity at 20° C.	1·054
Acid number	49·6
Saponification value	73·9
Ester number	24·3
Iodine value (Hubl. 18 hours)	105·04

A sample has been sent to the Imperial Institute for valuation.

"Boswellia-wax" is a very interesting modification of the "Boswellia-rosin." It is obtained by heating the residual resins in the still by a gentle fire below it. It may be said to be as brittle as "chlorinated wax." It gave the following constants:—

Specific gravity at 22° C.	1·087
Melting point	55—59° C.
Acid number	15·99
Saponification value	27·25
Ester number	11·26
Iodine value (Hubl. 18 hours)	119·1

It is easily soluble in petrol, turpentine and mostly in alcohol. It could perhaps be used in these solutions as a polish for metals and a glaze. A sample has also been sent to the Imperial Institute for suggestions and market valuation.

This enquiry will be continued as it appears a promising one.

Oil from *Schleichera trijuga* seed.—A quantity of Kosum oil was prepared for the Forest Economist and the theoretical and practical percentage was worked out for fresh seeds received from the Central Provinces.

The proportion of husks to kernel was 1 : 1·6, the kernel being 62·12 per cent. and the husks being 37·88 per cent.

The oil in the kernels determined by ether came to 65·90 per cent. 64 lbs. of these seeds were decorticated and 62·5 per cent. of kernels were obtained, the rest being thrown away as husks containing no oil. Forty pounds of these kernels were powdered and expressed hot in the hydraulic press by instalments. The residual oil-cake was once more expressed and the oil obtained mixed with the first lot.

The total oil weighed 23 lbs., which works to 57·5 per cent. The theoretical percentage obtained by ether extraction as already given was 65·9 per cent. out of which 57·5 per cent. is the workable percentage or 35·93 per cent. on the total seed, taking of course the husks to contain no oil.

Some mineral salts as fish poison.—An interesting case of the death of river fish by the soil washed down by a small tributary in the Mandal river in the Ramnagar Forest Division of the Western Circle, United Provinces, was referred to the Chemical Adviser by the Forest Divisional Officer. A short note on "Some mineral salts as fish poison" was published in the "Indian Forester" of November 1913. It was shown that the presence of ferrous sulphate was the cause of the dying of the river fish. They die apparently for want of oxygen. It was also shown that sodium sulphide is poisonous in its effects on river fish. A solution of ·05 per cent. of sodium sulphide kills fish in about half an hour and still more dilute solutions even up to ·001 per cent. would seem to have the same effect on them after prolonged action. Among other common salts, sodium chloride was proved to be equally deleterious.

Tannin value of *Terminalia paniculata*.—A sample of the bark of *Terminalia paniculata* was received from the Divisional Forest Officer, Belgaum, and examined last year. It gave the following percentages:—

Moisture.	Ash.	Total soluble solids.	Non-tannin.	Tannin.
11·61	17·43	35·52	94·5	26·07

As this tree is said to occur in great abundance in the Bombay forests it has been suggested that it may be well utilized for the manufacture of tannin extracts.

Tannin value of *Rhus mysorensis*.—Another interesting tan bark of *Rhus mysorensis* was received from the Extra Assistant Conservator of Forests, Ajmer. The dry bark yields a buff coloured powder on crushing. It was of the following composition:—

	Per cent.
Moisture	8·37
Total solids	39·90
Soluble solids	37·30
Insoluble solids	2·60
Non-tannin	15·07
Tannin	20·23

The tan liquor containing ·5 per cent. of tannin in 1 c.m. cell gave 34·5 red and 22·2 yellow. It is known to give a very good buff coloured leather. It was not considered suitable for tannin extract making, but

it would form a very good tannin material in the form of powdered bark, either for local use or for export.

Differentiation of timbers of *Dipterocarpus* from Burma.—The question of differentiating between the three species of *Dipterocarpus*, (1) "*In*," (2) "*Kanyin-ywet-gyi*" and (3) "*Kanyin-ywet-the*," by staining them was put by the Burma Forest Department. All the three woods being of similar nature, it is somewhat difficult to differentiate between them merely by staining. At the very outset, it was found that they are successfully stained green by Potassium Ferricyanide, but the difference in the depth of the stain as developed was not a very delicate test. It has been proposed to distinguish No. (3) "*Kanyin-ywet-the*" from the other two by the stain test to be carried out as follows:—

Take 5 grams of the thin shaving of each in separate beakers, add 10 c.c. of 10 per cent. solution of Potassium Ferricyanide and 50 c.c. of distilled water to each. After bringing all the three beakers to the boil, keep them boiling for 5 minutes. It will be seen that No. 3 is least coloured and Nos. 1 and 2 of equal depth. The observations should be made immediately after cooling. This test could be easily carried out in the field. It is important that this test should be carried out under identical conditions, taking the same quantities boiling for exactly the same number of minutes.

No. 1 was differentiated from No. 2 by the rate of the flow or "oozing." A resin test was also undertaken.

By combining both these tests, it has been possible to distinguish between these three timbers in the Laboratory with success. On repeated experiments similar results were obtained. This test has been successfully carried out in the field by Burma Forest Officers and it is being used there for differentiating *In* from *Kanyin* timber.

Siam cutch.—A sample of cutch manufactured in the Chiengmai District of Northern Siam was received from the Conservator of Forests, Siam, for analysis and opinion as to its dyeing and tanning properties. It was analysed with the following results:—

	Per cent.
Moisture	13·77
Ash	5·54
Total soluble solids	67·40
Insoluble in water at 28° C.	13·29
	100·00
Non-tannin	21·30
Tannin	46·10
Catechin	29·32
Absolute alcohol extract	82·62
Insoluble in alcohol	8·61

From its composition it is clear that this cutch is of an average composition and will do well as a dye, though it is doubtful if its deep colour will permit of its being used as a tannin agent. It should be classed as "Solid Burma Cutch," which is generally used for dyeing fishing nets in England. In India similar cutch under the name of red *katha* is sold for edible purposes.

The rubber of *Cryptostegia Grandiflora*.—A sample of this rubber was received from Messrs. McLeod and Company, Limited, Calcutta, for analysis. It gave the following percentage composition :—

	Per cent.
Moisture	6·83
Caoutchouc	69·48
Resin	11·70
Dirt	11·99
	100·00
Ash	3·8

The composition of the fruit of *Dillenia indica*.– On an enquiry made by Rai Bahadur Upendra Nath Kanji Lal in May 1914, the chemical examination of the fresh ripe fruits of *Dillenia indica* was conducted by Mr. T. P. Ghose, Scientific Assistant to the Chemical Adviser, and a note sent to the "Indian Forester" for publication. The analysis of the calyces of the fresh fruit was as follows :—

	Per cent.
Moisture	86·40
Alcoholic extract	3·00
Water extract	0·37
Insolubles	10·23

The aqueous extract represents only pectous matters left in the tissue after having extracted the calyces with alcohol. The alcoholic extract examined qualitatively showed the presence of tannin, glucose, malic acid and pectous bodies.

Malic acid was further identified by its lead salt.

The composition of the alcoholic extract obtained was as follows :—

	Per cent.
Moisture	8·20
Tannin	1·40
Glucose	12·15
Malic acid	2·21
Petroleum ether solubles (fats, etc.)	0·72
Albuminoids	0·85
Ash	12·63
Pectous matters	61·84
	100·00

The chief ingredients of the calyces of the fresh ripe fruits are tannin, glucose and malic acid. The percentages of these ingredients calculated on fresh and dry calyces stand as follows:—

—	On fresh calyces.	On dry calyces.
	Per cent.	Per cent.
(1) Tannin	0·05	0·37
(2) Glucose	0·40	2·92
(3 Malic acid	0·07	0·71

From the above figures, the conclusion is evident that the fruit could not be of any commercial use. Mr. Ghose has published a note on the subject in the "Indian Forester."

Salt worts from Madras.—Two different kinds of salt worts along with a sample of Barilla locally made, received from the District Forest Officer, South Arcot, were examined by Mr. T. P. Ghose. The District Forest Officer was anxious to know if the local method of manufacture of alkali could be improved. The sample was analysed with the result that it appears to offer little promise.

Indian Tapioca.—A sample of Tapioca starch made departmentally at Ajmer was received for analysis through the Forest Economist. It gave the following percentage composition:—

	Per cent.
Moisture	11·86
Starch	82·43
Fatty matters	0·12
Sugar, etc.	0·25
Cold water solubles (by difference)	4·15
Cellulose	0·64
Ash	0·55

Analysis of wild *Saccharum*.—Two samples of wild *Saccharum* canes were received from the Forest Botanist, consisting of four each of two different forms A and B. The sheaths were taken off and the inner canes were measured and cut into halves. The determinations of the cane sugar and glucose were separately made both on the lower and the upper halves of the canes A and B with the result that it is evident that sugar occurs in negligible quantities.

Preservation of the latex of *Ficus religiosa*.—An enquiry was made by a firm at Pathankot through the Forest Economist as to the best methods of preserving the *Peepal* latex without coagulation with a view to making it available for closing punctures in rubber-tyres. After some experiments, it was suggested that the sap should be preserved by mixing 1 part of the latex with 4 parts either of petrol, turpentine

or benzol and a few drops of formaldehyde. The latex was thus preserved for months. A short laboratory note is published in the "Indian Forester."

The distillation of Pine needle oil in India.—The distillation of Pine needles in Europe and America is an established industry. The Pine needle oil is used as a remedial agent against rheumatism and allied complaints. It is a volatile, colourless liquid obtained by distillation of fresh needles and young twigs. The Chemical Adviser distilled 90 lbs. of fresh chir needles with short twigs containing 59·30 per cent. of moisture by steam at a pressure of 10—15 lbs. which gave 0·57 per cent. of oil or 1·4 per cent. calculated on the dry material. This oil gave the following constants:—

Specific gravity at 20° C.	0·874
Optical rotation in 100 mm. tube	—6° 15′
Acid number	1·03
Saponification number (milligrams of KOH per one gram of oil)	15·54
Iodine value (Hubl. 18 hours)	271·2

A note on the subject entitled "A plea for the distillation of Pine needle oil in India" has been sent to the "Indian Forester" for publication.

The best season for collecting the Cus-Cus roots.—The roots of the *Cus-Cus* or *Khas Khas* grass (*Andropogon muricatus* Retz) are the source of the Vetiver oil of commerce. The yield of the oil has been variously stated. Seven samples of Indian Khas Khas have been examined with the results tabulated below:—

Serial No.	Locality.	Month of collection.	Moisture per cent.	Ash per cent. in washed roots calculated on dry materials.	Oil per cent. by steam distillation.
1	Godhra Range, Panch Mahals District, Bombay.	April, 1913	8·51	2·66	0·72
2	Ajmer, Rajputana	March, 1913	10·14	3·10	1·13
3	Pilibhit, United Provinces	April, 1913	10·46	4·30	0·69
4	Ditto. An inferior sample, thin white roots.	July, 1913	9·51	4·71	0·37
5	Belgaum Forest Division, Bombay	May, 1913	10·88	3·84	0·99
6	Yeotmal Forest Division, Central Provinces.	August, 1913	9·45	3·10	0·45
7	Delhi, from the bazar. The best long fibres received by native perfumers.	January-February, 1914.	9·81	2·97	1·14

All these samples came direct from the forests except the last one which was purchased at Delhi from the market. It was reported to be the best Khas Khas used for distillation by the native perfumers and distillers. The content of oil in roots of average good quality may thus be taken to vary from 0·7 to 1·0 per cent., a figure below 0·7 per cent. showing an inferior quality of grass.

The quality of the roots would mainly depend on the season of collection, other factors, such as, soil locality, etc., being of minor importance. According to the Delhi dealers, the roots for distillation are always collected towards the end of January.

The sample obtained from Delhi thus collected gives 1·14 per cent. of oil, while the sample collected in August, *i.e.*, in the rainy season, gives only 0·45 per cent. Samples from Pilibhit show a wide divergence, the sample collected in April giving 0·69 per cent., while another collected in July, *i.e.*, in the rainy season, giving only 0·37 per cent. All other samples, *viz.*, No. 1 collected in April give 0·70 per cent., No. 2 collected in March and No. 5 in May give nearly 1 per cent.

It thus seems evident that the roots should be collected towards the end of the winter season till the commencement of the rainy season.

The constants of Vetiver oil.—Seventy-five grams of Vetiver oil of dark brown colour were obtained by distilling the crushed roots by steam at a pressure of 40—50 lbs. It was redistilled in the Laboratory with a gentle current of steam for about 10 days till no more oil came over. All the fractions of the oil thus obtained were mixed together for determination of the usual constants. The residue was a dark red resinous mass which was extracted with alcohol. About 9·4 grams of a dark red resin of a brilliant fracture were obtained. It softened at 65° C. and completely melted at 70° C. It gave the following constants:—

Specific gravity at 30° C.	1·132
Acid number	46·92
Saponification number	111·20
Ester number	64·28
Iodine value (Hubl. after 18 hours)	268·20
Optional rotation calculated on 10 c.c. of the solid resin	488·04 approximately.*

The redistilled oil which was of a yellowish brown colour and quite transparent gave the following constants:—

Specific gravity at 15° C.	1·011
Optical rotation in 100 mm. tube	−30°·65
ND. 20° C.	1·5165
Acid number	10·5
Saponification number	80·1
Ester number	69·6
Saponification number after acetylization	132·8
Iodine value (Hubl. 18 hours)	194·4

Soluble in two parts of 80 per cent. alcohol.

* Because the solution had to be made too dilute for observation owing to the too dark colour of the resin.

The above constants are different from those already recorded by various observers. This difference may be due to the elimination of the resin from the oil by redistillation. At least, in optical rotation, it is mainly due to this cause. The angle of rotation of the oil in this case is about $-31°$, while all observers have recorded for *vetiver* oil a rotation of $+25°$ to $+40°$. The optical rotation of the resin is $+488°{\cdot}4$. Taking the proportion of the oil to resin as it is in this case to be 8 : 1, the optical rotation calculated on the mixture of resin and oil comes to $+34$. It seems the dextro-rotation of the oil is due to the small proportion of Khas Khas resin. This will also have its effect on other constants.

A short note on the subject has been published in the "Chemist and Druggist," London. Another dealing with the commercial side of the distillation of the grass is under preparation.

List of Publications.

GHOSE, T. P. . . The composition of *Dillenia indica*. (*Ind. Forester, Aug. 1914.*)

SINGH, PURAN . . Note on Turpentine of *Pinus Khasya*, *Pinus Merkusii* and *Pinus excelsa*. *For. Bull. No. 24 of 1913.*)

,, ,, . . Some Mineral Salts as fish poisons. (*Ind. Forester, Nov. 1913.*)

,, ,, . . A further Note on the Calorimetric tests of some Indian woods from Belgaum. (*Ind. Forester, March 1914.*)

,, ,, . . Preservation of the Latex of *Ficus religiosa*. (*Ind. Forester, Sept. 1914.*)

,, ,, . . Nickel Tannates. (*Journ. Soc. Chem. Ind., 28th Feb. 1914.*)

,, ,, . . A plea for the distillation of Pine needle oil in India. (*Ind. Forester.*)

,, ,, . . The Salt-worts from Madras. (*Ind. Forester.*)

,, ,, . . A Note on the Indian Vetiver Oil. (*Chemist and Druggist, London, No. 1802, Vol. LXXXV.*)

ASTRONOMY.

BY

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Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the

centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disk in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Rowland with $3\frac{1}{4}$-inch ruling is usually employed.

(*d*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during employment of the spectroheliograph and associated instruments.

(*e*) An 8-inch visual achromatic lens from the Maharajah Takhtasinji Observatory, Poona, temporarily mounted in the spectroheliograph room on a pier near the Foucault siderostat. It is used for forming a solar image on the spectrograph slit specially for sunspot work.

(*f*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on Rowland's plan. A 2-inch parabolic grating can be sub-

stituted for the concave grating, and a collimating lens may be employed with either grating to cure astigmatism.

(*g*) A 6-inch equatorial refractor with large grating spectroscope attached is used for the study of sunspot and prominence spectra and for recording the prominences by visual methods. The equatorial mounting and the spectroscope are from the Maharajah Takhtasinji Observatory, Poona.

(*h*) A 6-inch equatorial refractor by Lerebour and Secretan fitted with a photovisual object glass acquired from the Poona Observatory. The instrument is used for obtaining the daily series of large scale photographs of the sun, and for direct observations.

Routine work.—In addition to the daily records obtained by the two spectroheliographs, the routine work includes visual examination of sunspots and faculæ, sunspot spectra, and bright lines or displaced lines in spots and prominences. The position angles and forms of the prominences are also recorded. A monthly article describing the solar activity is contributed to the "Monthly Weather Review," while for more technical purposes bulletins and memoirs of the Observatory are issued; of the former 38 have appeared and of the latter the first has been published.

Solar work in Kashmir.—From observations made with a small telescope during the months of August and October 1913 it was found that the atmospheric conditions were extraordinarily favourable for solar research work in the valley of Kashmir. This valley is a plain elevated 5,200 feet above sea-level and completely surrounded by mountains rising 10,000 to 15,000 feet higher. Owing apparently to the stillness and homogeneity of the air thus enclosed, the definition of the sun was found to be invariably excellent, not only on different days, but at practically all hours of the day.

In order to discover whether these remarkable conditions held during other months of the year an expedition was organised to carry out observations on a more extended scale during the months, May, June, July 1914. The general result of this work is to confirm the earlier observations and to show that the good conditions of seeing prevail during these months also. Contrary to all previous experience on mountain tops and in hilly country, the solar definition in the Kashmir valley does not deteriorate as the sun rises high in the sky, but actually improves from 8 A.M. up to 2 or 3 P.M. Under these conditions it would be possible to get very valuable series of photographs of the solar surface or of prominences showing the changes taking place from hour to hour.

Spectroscopic investigations.—The residual displacements of the iron lines of the solar spectrum towards the red, when the displace-

ments due to the earth's movements and to the solar rotation are eliminated, have been studied in detail, and the definite conclusion has been reached that pressure is not appreciably concerned either in the small shift in the lines at the centre of the sun's disk or in the larger shift of the lines at the limb. The only possible explanation of these shifts appears to be motion in the line of sight, a motion which is directed away from the earth all over the disk and all round the circumference at the limb. This movement would seem to imply that the earth itself repels the solar gases, a result which would be incredible but for evidence derived from the distribution of sunspots and prominences which also implies an earth effect.

In the course of these investigations, in which the solar spectrum is compared with that of the iron arc, many of the solar lines were found to be relatively shifted towards the violet, and others had unusually large shifts towards the red. These abnormal displacements were found to vary according to the length of the arc employed, which suggested that certain iron lines were displaced under different conditions of the electric arc. The spectra of the elements sodium, calcium, and several others were also compared with the sun's spectrum, and it seemed likely that the abnormal displacements for these substances, which were at first thought to be due to differences of level in the sun, were also due to the same cause as the abnormal displacements for iron. The same law seems to hold for all substances, namely, that those lines which under pressure widen unsymmetrically towards the red are relatively displaced in the sun towards the violet, and lines which are unsymmetrically widened towards the violet show larger displacements towards the red than lines which are symmetrical.

The displacements of lines under different conditions of the electric arc have therefore formed the subject of a new investigation, and it has been found that displacements of unsymmetrical lines occur in the regions of the arc near the poles, and can be produced at the centre of the arc by decreasing its length or by increasing the current strength. The direction of displacement is in each of these cases in the direction of greater widening. Symmetrically widened lines are, on the other hand, practically uninfluenced by the arc conditions. The largest displacements were found in the region near the negative pole as compared with the centre of the arc.

The cause of these displacements has been shown to be differences of density, and from the direction of the solar displacements it is concluded that the density of vapour in the sun's reversing layer is less than that of the vapour at the centre of a long arc burning in air. The existence of the density displacement seriously limits our means of estimating pressure in the reversing layer, since the lines most affected by pressure are generally speaking those subject to density effects. The density shift

can, however, be differentiated from the pressure shift, because density does not displace symmetrical lines.

List of Publications.

EVERSHED, J. . .	A new method of measuring small displacements of spectrum lines. (*Bulletin No. xxxii.*)
,, ,, . .	A new interpretation of the general displacement of the lines of the solar spectrum towards the red. (*Bulletin No. xxxvi.*)
ROYDS, T. . .	A comparison of the Periodicities in Prominences and Sunspots. (*Bulletin No. xxxiv.*)
ROYDS, T., & S. SITARAM AIYAR.	The apparent effect of planets on the distribution of prominences. (*Bulletin No. xxxv.*)
ROYDS, T. . .	Summary of prominence observations for the second half of the year 1913. (*Bulletin No. xxxvii.*)
,, ,, . .	A preliminary note on the displacement to the violet of some lines in the solar spectrum. (*Bulletin No. xxxviii.*)
ROYDS, T., & EVERSHED, J.	On the displacements of the spectrum lines at the sun's limb. (*Bulletin No. xxxix.*)

METEOROLOGY.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Upper air investigations.—The building of the new observatory at Agra was little advanced at the end of the year, and temporary quarters had to be employed there. In these circumstances experimental work was confined to the observation of pilot balloons at Simla, Darjeeling and Agra, and the preparation of apparatus for Allahabad and Kojak (Baluchistan), two new stations which were to be started early in 1914-15. A staff of computers continued the reduction of past observations on balloons.

Arrangements were made for regular cloud observations in various parts of India to supplement the observations with pilot balloons.

Statistical investigations.—(*a*) *Solar influences.*—It is clear that the variations of Indian seasonal rainfall are associated with big inter-related meteorological oscillations that occur over large areas of the earth's surface; and these may naturally be regarded as largely dependent on variations in the heat sent out by the sun. Reliable measurements of this heat radiation have only been made for a few years, and in order to ascertain the meteorological effect of the sun it appears desirable to examine the relation of sunspot numbers with the conditions of rainfall, pressure and temperature over the earth's surface. A memoir regarding the effect on rainfall is practically complete and data for the remaining elements have been prepared.

(*b*) *The forecasting of monsoon rainfall.*—A memoir has been published as to the effect of India pressure in the previous year, India temperature in May, and the amount of ice in the southern seas in the total monsoon rainfall of India; and a systematic effort has been made to develop methods of forecasting the geographical distribution of monsoon rainfall. The peculiarities of the Indian pressure distribution in May have been shown to have no appreciable influence; but the May pressure of India as a whole and some of the factors on which the forecast of the total rainfall is based have been found to have a marked influence; these investigations are still incomplete, but it is expected that progress will result from them.

Publications.—The customary Daily Weather Reports of Simla, Calcutta, Bombay and Madras, the monthly and annual supplements to the Simla Daily Weather Report, the Monthly Weather Reviews, the

Annual Summary, and various administrative pamphlets were issued during the year.

List of Publications.

SIMPSON, G. C. . Potential Gradient at Simla, India. (*Memoirs, Part vi.*)

WALKER, GILBERT T. Monthly and annual normals of number of rainy days. (*Memoirs, xxii, Part ii.*)

" " A further study of relationships with Indian monsoon rainfall. (*Memoirs, xxi, Part viii.*)

" " . Correlation in seasonal variations of Weather, III. (*Memoirs, xxi, Part ix.*)

TERRESTRIAL MAGNETISM.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,
Director-General of Observatories.

Magnetic observatories.—*Bombay (Alibag).*—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city: it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern, a set of sight-reading instruments of Eschenhagen pattern, a Schulze earth-inductor, and ordinary magnetometers and dip-circles. There is also a large declinometer for eye observations, and the old Colaba horizontal force and vertical force magnetographs were in April 1912 transferred to Alibag for use as eye-reading instruments. There is thus a duplicate equipment both for absolute values and for variations.

The instruments have been in good order and under regular observation.

The number of absolute observations, as already reported last year in connection with the investigations relating to the stability of the base line values of the magnetographs, was materially altered from the year 1912 to suit requirements. The number of absolute observations, some eight in the month for each of the elements H and D, was found sufficiently large to allow fairly correct daily values of H and D to be derived from these bi-weekly observations by standardising the curves and base line values of each day of the month. In the case of the vertical force magnetograph, however, the base line was found to be so unstable and unreliable from day-to-day that for securing correct daily values of V there remained no alternative but to institute daily observations of inclination by the Inductor for standardising the curves and base line values from day-to-day. Observations with the Inductor in a moist and warm climate like that of Alibag require great care and attention for the necessary accuracy of results; and this difficulty was much accentuated by the heavy strain of daily use to which the Inductor had been subjected under the revised routine. All reasonable precautions were of course taken to ensure accuracy, but as there was no effective check on these observations, it was deemed advisable to supplement other observations with a duplicate Inductor. This has been obtained and installed on the first floor of the magnetometer office.

Dehra Dun, Kodaikánal, Barrackpore and Toungoo.—These observatories were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained throughout the year.

The mean values of the magnetic elements for 1913 at the observatories are as follows:—

Observatory.	North Lat. and East Long.	Declination.	Horizontal force.	Vertical force.	North dip.
			C. G. S.	C. G. S.	
Alibag	18° 38′ 72° 52′	E 0° 47′ 33″	·36880	·16472	24° 2′·6
Dehra Dun	30° 19′ 19″ 78° 3′ 19″	E 2° 22′·2	·33191	·32359	44° 16′·4
Barrackpore	22° 46′ 29″ 88° 21′ 39″	E 0° 38′·0	·37388	·22387	30° 54′·8
Kodaikánal	10° 13′ 50″ 77° 27′ 46″	W 1° 11′·2	·37553	·02686	4° 5′·5
Toungoo	16° 55′ 45″ 96° 27′ 3″	E 0° 7′·8	·38963	·16605	23° 5′·0

Magnetic Survey.—*Field Operations, 1913-14.*—As it was considered desirable to push on with the reduction of the mass of data already accumulated, detailed survey operations were discontinued and field work was confined to observations at repeat stations for the determination of secular changes and to comparisons of instruments at observatories: this work was carried out by two detachments under the Officer in charge (Captain Thomas, R.E.) and a provincial officer. In December 1913, however, the magnetic survey party was directed to carry out special detailed magnetic surveys in the districts of Poona, Nasik and Ahmadnagar in connection with the proposed establishment of one of the stations of the Imperial wireless chain. A third detachment under a provincial officer took the field for the same purpose, but after completing work in the Poona district, amounting to 30 stations in all, instructions were received to discontinue the operations.

Work during recess season, 1913-14.—The reduction and tabulation of the data for the four survey base stations for 1913 have been completed; the mean values for the year 1913 derived from all days, excluding those of great disturbance, are given in the table appended to this report.

The computation of the field observations during 1913-14 has been completed and that of the observatory work during 1914 has made good progress.

The reduction of the field observations in Horizontal Force to the selected epoch has been put in hand: hitherto only the declination data has been dealt with.

Committee on the present position of the magnetic survey.—At the suggestion of the Surveyor-General a committee was appointed by the Government of India in March 1914 to consider the present position of the magnetic survey and advise as to the steps to be taken to complete it. The committee, consisting of Dr. G. T. Walker, C.S.I., F.R.S., as president and Captain Thomas and J. deGraaff Hunter, Esq., of the Survey of India as members, sat for a fortnight in March 1914.

The report of the committee will be published *in extenso* in the *Records of the Survey of India;* their main conclusions and recommendations may be summarized as follows:—

(1) The field work of the first general magnetic survey is complete and the work of reduction to epoch should now be pressed on.

(2) The process of reduction usually followed may be simplified and the labour involved thereby considerably reduced.

(3) The survey can be brought up to date at any future period by maintaining an adequate number of observatories in continuous operation and by preservation of the present repeat stations.

Programme for 1914-15.—During the next field season field work will be confined to observations at repeat stations and comparisons of instruments at observatories.

The primary object of revisiting the repeat stations is to erect suitable marks so that the exact position of the stations may be identified at any future date: in the meantime the care and preservation of the marks will be entrusted to the local authorities as recommended by the committee on the magnetic survey. At present the sites of repeat stations are marked by brick or concrete pillars, two feet square with the top surface flush with the ground; experience has shown that the life of such marks is very short.

The bulk of the strength of the magnetic party will be employed on the work of reduction of the survey to the selected epoch.

GEOLOGY.

BY

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Director, Geological Survey of India.

CONTENTS.

MINERALOGY AND PETROLOGY.

1. **Hambergite from Kashmir.**—Amongst the collections of minerals brought by Mr. C. M. P. Wright from the sapphire mines of Padar in Zanskar were found some crystals of hambergite, a mineral not hitherto recorded as occurring in India. The specimens were examined and a description of them has already been published by Mr. R. C. Burton in Vol. XLIII of the *Records of the Geological Survey of India*.

2. **Hybrid pyroxene gneiss.**—Numerous crystalline rocks of interest have been recorded by Messrs. Fox and Burton in the course of their work in the Central Provinces. One of these may be referred to here, being regarded by Mr. Burton as one of the peculiar forms known as hybrid rocks. The rock in question occurs at the junction between a coarse pegmatite and a mass of pyroxenite which has been caught up in the pegmatite. Near the contact the pegmatite contains green amphibolite and is welded on to the hybrid rock, which consists of large white and pink porphyritic crystals of felspar and irregular quartz grains in a matrix of small brecciated felspar fragments, green amphibole and a little pyroxene. This rock is regarded as a hybrid pyroxene gneiss,

and as undoubtedly produced by the intermingling of the pegmatite magma with the pyroxenite and the subsequent recrystallization of the whole as a felspar-quartz-amphibole rock.

3. **Andesite in Korea coalfield.**—An interesting type of rock, which has been designated as an unusual variety of andesite, was found by Dr. L. L. Fermor in the neighbourhood of Chirmiri near Kurasia in the Korea State in the Central Provinces. The rock in question is vesicular, and would at first sight appear to be a surface lava. Its linear distribution, however, suggests a dyke, a supposition which is borne out by the fact that it contains fragments of the Gondwana rocks with which it is associated. On the other hand, the rock appears occasionally to be almost pumiceous in character, and this, with its vesicular nature, would lead to the conclusion that it was extrusive. On the whole, Dr. Fermor leans to the conclusion that the rock is intrusive. Under the microscope it is found to be of felspar microlites in a colourless to black glassy matrix, often vesicular. In the most coarse-grained crystalline variety the laths are found to consist of labradorite, set in a glassy matrix containing skeleton crystals of magnetite, but no augite. The rock, therefore, appears to be an unusual variety of andesite corresponding in composition to the ground-mass of a typical andesite, the ferro-magnesian silicates being absent.

PALAEONTOLOGY.

4. **Tertiary mammals.**—Dr. G. E. Pilgrim acted as Palæontologist throughout the year. He was engaged on the examination of the specimens collected by himself and by Sub-Assistant Vinayak Rao, which enabled him to form the conclusions embodied in his paper on "The correlation of the Siwaliks with mammal horizons of Europe," which has already been published in the *Records of the Geological Survey of India*, Vol. XLIII.

5. **Tertiary molluscs and nummulites of Sind.**—From the date of his return from the field early in April until the end of the year, Mr. Vredenburg was employed at head-quarters in completing his description, on which he has been engaged for the past eight years, of the Tertiary fossils of Western India. It is hoped that this may be ready for the press in the course of the next few weeks. He has also revised his descriptions of the nummulites of Western India, which was completed some years ago but has not yet been published owing to the difficulty met with in obtaining satisfactory photographs of the specimens described.

6. **Echinoids of Baluchistan and Tibet.**—In addition to his work on Tertiary *Mollusca* and *Foraminifera*, Mr. Vredenburg has re-examined certain Cretaceous and Tertiary echinoids collected in

Baluchistan and in Tibet, and finds that some of the generic determinations, originally made by Dr. Noetling, require some slight modification. Thus the species *Echinanthus Griesbachi* appears to belong to a genus which does not strictly conform to the characters of *Echinanthus*, and is probably new. Again, *Pyrina gigantea* Noetling appears to belong rather to the genus *Echinoconus*, and seems to be specifically indistinguishable from *Echinoconus Douvillei* from the Mæstrichtian of Persia. The Tibetan echinoids come from the Kampa system, and appear to belong to three separate faunas, the oldest being Cenomanian, the next Mæstrichtian, and the third probably Eocene.

7. **Palæontological work in Europe.**—During the year under review, descriptive palæontological work on behalf of the Geological Survey has been carried out in Europe by Professor A. C. Seward and Mr. F. R. Cowper Reed at Cambridge, by Professor H. Douvillé in Paris and by Dr. C. Diener in Vienna. Mr. S. S. Buckman has also continued his investigations with regard to the brachiopods of the Northern Shan States. Among the results of the above work may be recorded a paper on *Camarocrinus asiaticus* by Mr. Cowper Reed, and an account of the Anthracolithic fossils of Kashmir and Spiti by Dr. Diener. The former paper, which has already been published in the *Records of the Geological Survey*, deals with certain features not preserved in the specimens which had been previously described and adds considerably to our knowledge of the species. Dr. Diener's description of the Anthracolithic faunas of Kashmir and Spiti deals with the large collection made during recent years by Mr. C. S. Middlemiss from the Carboniferous and Permian rocks of Kashmir, and the collections made by me during the summer of 1901 from the Carboniferous rock of Bashahr and Spiti. The fossils from Kashmir were derived from the Syringothyris limestone, from the Fenestella series and from the Zewan beds. The fauna of the Syringothyris limestone, although rich in individuals, is poor in number of species, there being altogether fourteen species of brachiopods, of which, however, only four were found to be specifically determinable. The presence of *Syringothyris cuspidata* Mart., however, indicates that this horizon, like the Lipak limestone of Bashahr, is of lower Carboniferous age. The fossils from the Fenestella series are much more numerous and include altogether 41 species, of which thirty are brachiopods, six lamellibranchs, three *Bryozoa*, one a *Conularia*, and one a trilobite. Although our knowledge of the fauna of the Fenestella beds of Kashmir is thus considerably increased, the question as to their stratigraphical position is still doubtful. Out of the 41 species 20 are unfortunately new, and are known only from the Fenestella beds, while 12 are so imperfectly known as to be of no critical value. The fauna, however, is markedly different from that of the Zewan beds, and Dr. Diener concludes that it is considerably older than Permo-Carboniferous. In certain respects it resembles that of the Lower Carboniferous and in others that of the

Middle and Upper. Its age, therefore, as referred to the European stratigraphical scale, is still uncertain. The fauna of the Zewan beds is still more extensive, containing altogether 59 species distributed as follows: brachiopods 46, lamellibranchs 7, cephalopods 2, *Bryozoa* 2, gastropod 1, and *Anthozoon* 1. Again the brachiopods predominate enormously. The identity of the fauna of the Zewan stage with that of the Productus shales of Spiti and the Central Himalaya generally is attested by the fact that out of 44 species of the former fauna which are specifically determinable 33 are common to both; *Xenaspis carbonaria,* which had already been found in the Salt Range, in Kumaun, and in Spiti, has now been found also in Kashmir.

8. The fauna from the Carboniferous limestone of Bashahr and Spiti contains only 24 forms which are specifically determinable. Several of these, however, are characteristic, and include *Syringothyris cuspidata.* The fauna, on the whole, is closely related to that of the European and American Lower Carboniferous. It is hoped that Dr. Diener's paper will be published in the *Palæontologia Indica* during the current year.

ECONOMIC ENQUIRIES.

Building Stone.

9. **Marble and sandstone.**—In connection with the preparation of plans and estimates for the building of Imperial Delhi, the services of an officer of this Department were urgently called for during the last hot weather in order that he should accompany an engineer of the Public Works Department on a visit to certain quarries in Central India and Rajputana with a view to reporting on the quality and quantity of building stone likely to be obtainable from them. Mr. H. C. Jones was instructed to take up the work, and left Calcutta about the middle of May, the most unfavourable time of the year at which to take up an investigation of the kind. Mr. Jones deserves great credit for the promptness with which he responded to the call on his services and the thorough manner in which he carried out the work under the most trying climatic conditions. The investigations were largely restricted to Native States in which are to be found most of the suitable marble and sandstone lying within reasonable distances from Delhi. The stone required included white marble, black marble, buff sandstone and dark red sandstone. In the case of the marble deposits, very little quarrying and practically no prospecting had been done previously, whilst, in the case of sandstone, the rock has frequently been very irregularly quarried, the old quarries being filled and the surface covered with débris. No reliable information, therefore, could be obtained as to the amount of rock available in most of the old quarries.

10. White marble was found to occur in large quantity, but rarely free from crystals of yellowish-green tremolite, which spoils the appearance of the rock. The best marble found was that of Maundla in Jaipur. A good marble similar to that of Maundla occurs also near Dhadakir in Alwar, but lies at a considerable distance from the railway.

11. The difficulty of obtaining black marble in India is not a new one, most of the so-called black marbles being usually gray. The best material within reasonable distance of Delhi appears to be that which occurs at Bhainslana in Khetri. It has been found by Mr. Heron to occur amongst a group of crystalline limestones, furnishing a variety of marbles of all colours which are in extensive use for local demands. The quarries, however, are situated at a great distance from the railway. A black shale, which might serve the purpose of black marble, is found near Kho in Alwar.

12. Large quantities of buff sandstone were found to be easily obtainable from quarries already in operation in the Dholpur State. The dark red sandstone, which is so familiar from its use in the Moghul buildings of Delhi and Agra, is frequently mottled with buff spots, which detract seriously from its appearance, but stone of good quality and in large quantity appears to be available in the Paharpur quarries in Bhartpur State and in the Nurpur quarries in Dholpur State.

13. Considerable difficulty has recently been experienced in obtaining marble from Makrana at a sufficiently rapid rate for the requirements of the Victoria Memorial now being erected in Calcutta. I paid a visit to the Makrana quarries early in the year and subsequently accompanied His Excellency the Governor of Bengal on a visit to them in September. The quarries were examined in detail, and it was found that the quantity available was ample for the purpose. Certain recommendations were made as to the extension of the present quarries, and these, if adopted, will probably result in an increase in the rate of output.

14. During his survey of Jaipur, Mr. Heron visited the freestone quarries of Raghunathgarh (lat. 27° 40′; long. 75° 23′). The rock is white and fine-grained and is obtained in very large, thick slabs, which are despatched often to great distances. There is a considerable local trade in quarrying and carving the stone, which would be more extensively used if the locality were not so far from the railway.

Coal.

15. **Korea coalfield.**—At the request of the Chief Commissioner of the Central Provinces, Dr. L. L. Fermor undertook the examination of the coalfields lying in the Korea State and previously referred to in *Memoirs, Geol. Surv. India*, Vol. XX, pt. 3. These fields lie on the continuation of the Rewah Gondwana basin. The area examined falls conveniently into two fields, which Dr. Fermor has named the Sanhat field

and the Kurasia field, the latter being sub-divided again into the Kurasia area and the Chirmiri area. In the Sanhat field two seams were examined, the lower of which is valueless in the western half of its course, but shows thicknesses of over 4 to 9 feet over a length of 16 miles in the eastern part of the field. The upper seam is valueless in the east, but ranges from $3\frac{1}{2}$ feet to nearly 10 feet in the west. The result of a considerable number of assays shows that neither seam is of good quality, the ash content ranging from 15·38 per cent. to 32·24 per cent. in the case of the lower seam and from 22·98 to 36·68 per cent. in the case of the upper. In the Kurasia field 6 coal horizons were found, in one of which (horizon 4) there are from 2 to 5 seams, ranging in thickness from 1 foot to 8 feet 6 inches. This horizon is supposed to cover about 4 square miles, in which case an average thickness of the coal of, say, 5 feet would correspond to $5\frac{1}{2}$ million tons per square mile. This, however, must still be proved by boring. Numerous samples taken show that the coal of this area is better than that of the Sanhat field, the ash content ranging from 9·32 per cent. to 13·82 per cent., the average composition of all samples being—

	Per cent.
Moisture	8·66
Volatile matter	30·92
Fixed carbon	48·86
Ash	11·56

The dip of the coal ranges from 5° to 15° to N. N. W.

16. Still better coal is found in the Chirmiri area of the Kurasia field, where the finest seam of coal in the State is exposed in the Kauria stream above and below a waterfall known as the Karar Khoh. Seven seams, aggregating 13 feet in thickness, were observed, the average assay value being—

	Per cent.
Moisture	7·7
Volatile matter	29·1
Fixed carbon	51·2
Ash	12·0

This series of seams appears to thin out gradually in all directions; but Dr. Fermor considers that there is from 1 to $1\frac{1}{2}$, possibly even two, square miles, over which the coal is at least 10 feet thick. It is estimated, therefore, that at least 7 million tons of good coal are available, possibly a considerably larger quantity. The dip of the seams is always very low, usually almost horizontal.

17. Both the above fields show faulting, although not on an extensive scale, the faults being generally small and not very numerous. On the other hand, the seams are frequently found to vary greatly in thickness in a short distance. The roof is usually sandstone, massive and, though

rather friable, probably fairly sound. A complete account of these coalfields is now in the press, and will be published shortly in the *Memoirs of the Geological Survey of India.*

Cobalt.

18. **Jaipur.**—The *sehta* (cobaltite and danaite) of the Babai (lat. 27° 53′; long. 75° 48′) and Bagor copper mines in Jaipur (*see* V. Ball, *Man. Geol. India*, pt. 3, p. 324, and F. R. Mallet, *idem*, pt. 4, p. 27), Mr. Heron remarks, was worked until as recently as only four years ago, when it was displaced by a dearer but purer imported substance for use by the Jaipur enamellers. The *sehta* consists of minute silvery crystals sparsely scattered through the same black slates which contain the copper pyrites (see *infra*). These come below the quartzite on which the Khetri and Bagor forts stand and are almost continuous from Singhana to Babai. The workings are quite irregular and follow the general direction of the dip of the slates at a steep angle of from 30° to 60°. The ore is in irregular strings, layers and lenticles, without any semblance of a true lode. The black slate country rock is more or less siliceous and splintery with indefinite bands of impure quartzite and amphibolite intrusions.

Copper.

19. **Jaipur.**—Mr. Heron during his survey of Jaipur visited the old and well-known copper mines at Singhana, Khetri and other places in the State (see *Ball, Man. Geol. India*, pt. 3, p. 260). No work is reported as proceeding now except casually for the extraction of alum, copper sulphate and ferrous sulphate from the efflorescence which coats the walls of the mines, though Mr. Heron remarks that there appears to have been a revival of the industry as recently as 12 years ago during the reign of Rajah Jai Singh. Among the various reasons given for the stoppage of the works none appear to be due to exhaustion of the ore, competition with imported copper or scarcity of fuel. Mr. Heron says: "I saw a lot of ore in the walls, and the miners say that beneath the water which partially fills the mines there is abundance still untouched. The mines are in a very ruinous and dangerous state . . . Adequate exploration of the mines and proper arrangements for their drainage by horizontal adits and water lifts would be an expensive business and would require perhaps several years of consistent policy, but the possible profit is greater than that held out by many enterprises engaged in by Native States."

20. **Dholpur.**—At the request of the Dholpur Durbar, Mr. Heron visited a supposed copper mine in that State near the fort of Kuargarh. The copper, however, was found to consist of only small quantities of malachite occurring along joints and between the grains of the sandstone,

such little quantity as there was having now been almost entirely removed. Mr. Heron thinks it probable that the mine was formerly merely a stone quarry in the Upper Bhander sandstone.

Gold.

21. **Burma.**—Mr. H. S. Bion completed his investigation of the gold-bearing alluvium of the Chindwin river, and the results have already been published in the *Records of the Geological Survey* (Vol. XLIII, pt. 4). After examining all the important localities, Mr. Bion came to the conclusion that the Chindwin gravels cannot be worked profitably except on the small scale at present adopted by the local inhabitants.

22. **Central Provinces.**—Mr. R. C. Burton records the occurrence of gold in the sands from the river beds of the Bawenthuri and Pachdar streams in the Seoni district of the Central Provinces. Washing is carried on by the natives during the rains, the average amount won being only 3 or 4 annas worth per man per diem.

Gypsum.

23. Mr. Heron paid a visit to the gypsum deposit which occurs in the Chamba valley in Dholpur State. This was found to be a local lacustrine deposit containing fresh-water shells. It is small and of no economic value.

Iron.

24. Among many occurrences of this mineral in Jaipur State Mr. Heron specially mentions a locality $1\frac{1}{4}$ miles west of Raipur (lat. 27° 44′; long. 76° 0′) where two vertical bands of massive hematite varying from 3 to 15 feet in width, and apparently free from visible impurities, occur in mica schist and are traceable at intervals along the strike for 2 miles.

Manganese.

25. **Central Provinces.**—Small deposits of manganese are recorded by Mr. R. C. Burton from the area to the south of the Korai ghats in the Seoni district of the Central Provinces. Some of the localities enumerated might possibly be worth exploration. These are:—

(1) on the Bhandara-Seoni boundary S. W. of Khirki, where quartzite is found impregnated with manganese-ore;

(2) $\frac{1}{4}$ mile west of Dhobitola, quartzite impregnated with manganese-ore is found interbedded with two or three thin bands of fairly pure ore;

(3) on the same road from Dhobitola to Dulapur, a small band of ore occurs 200 yards east of Thuyaghak stream;

(4) 600 yards west of the same stream a small outcrop of ore occurs on the road;

(5) an outcrop of manganese-ore with blue quartzite is found at the western edge of a small hillock about 250 yards north of Chichuldoh village. It is from 20 to 25 yards wide, and was traced for about 160 yards to the west of the hill. It is of poor quality, consisting largely of gondite impregnated with manganese-ore;

(6) small blocks of ore were found to west of Chichuldoh, and a small deposit is seen in the stream half a mile to the south-west of the village. These, however, are thin bands, probably of no importance.

26. **Dholpur.**—At the request of the Dholpur Durbar Mr. Heron visited Kesarbagh, where manganese-ore was supposed to occur. Only very small quantities were found occurring in the form of a few plates deposited along joint-planes. The occurrence is of no economic value.

Petroleum.

27. **Punjab and North-West Frontier Province.**—During a part of the year Dr. E. H. Pascoe was engaged on an investigation of the petroliferous localities of the Punjab and the North-West Frontier Province.

His work was unfortunately interrupted, first, by illness, and subsequently by deputation out of India, and it is hoped that the work may be resumed next field-season.

The following areas were visited:—

(*i*) Sudkal near Fatehjang, in the Rawalpindi district. Three well-known seepages of oil occur here, 3 miles N. W. of Fatehjang. The rocks exposed belong to Wynne's "Upper Nummulitics," which probably include some of Mr. Middlemiss' Kuldanas. They consist of nummulitic bands interstratified with iron-stained sandstones or clayey sands and occasional "pseudo-conglomerates." Nummulites are extremely plentiful and poorly preserved pelecypods and gastropods occur. The structure is complex and ill-suited for oil-retaining purposes. Two or three tightly packed and deeply denuded small anticlines, separated by equally small synclines, characterise the area, extending in an E.-W. direction. The seepages probably occur on a dip fault.

(*ii*) Chharat, five or six miles W. N. W. of Fatehjang. There are several seepages here, lying upon an E.-W. fold. The rocks are identical with those at Sudkal. The crest of the anticline is sharply bent and the narrow fold deeply denuded. The prospects of obtaining oil in commercial quantity are scarcely less inferior to those at Sudkal.

(*iii*) Jafar, $1\frac{1}{2}$ miles S. W. of Chharat. There are no natural surface indications of oil at this spot, which was inspected because a boring put down in 1896 is reported to have met with a slight trace of oil. The structure is unfavourable and there is considerable doubt whether any trace of oil was actually found, as reported.

(*iv*) Chak Dalla, 3 miles N. N. E. of Bhatiot. Two seepages of bitumen are recorded in the Kala Chitta Range to the north of the Potwar plateau, but one appears to have been covered up. The rocks are nummulitic in age, but different from those of the Potwar. They consist mostly of hard, massive, bluish limestone, weathering in a curious groove-like manner and showing here and there traces of nummulites. Thin soft bands full of nummulites and some horizons with pelecypods and gastropods are not uncommon. Artifical groups of strata were mapped and the structure demonstrated to be that of a long tightly folded anticline pitching westwards towards the railway cutting. The fold is composed of a thick series of beds and has been denuded sufficiently to leave very little of the crest behind. The fold, whose direction is E.-W., is much larger than those around Sudkal and Chharat, but the prospects from an oil-prospecting point of view are not good, and the intractability of the ground, the hardness of the rock, and the uncertainty of the existence of porous rock, offer little inducement to prospectors.

(*v*) Ratta Hotar, 10 miles N. of Rawalpindi. The rocks are similar to those at Chak Dalla and consist for the most part of massive limestone with traces of nummulites here and there. This limestone is faulted against the red shales, pseudo-conglomerates and olive sandstones of the Murree series, and has been severely folded in an intricate way. A small seepage of oil associated with hydrogen sulphide occurs not far from the fault. The severe folding and impervious nature of the beds are unpromising.

(*vi*) Panoba, a day's march N. of Khushalgarh in the Kohat district. The rocks of this area which is more or less

in a line with the Kala Chitta Range, are similar to those at Chak Dalla, but comprise a greater thickness of softer beds. The map shows a well developed anticline but little, if any, of the crest remains intact, as the fold has been deeply denuded, and the prospects of an oil supply are doubtful. Three seepages occur where the fold pitches.

Kotehri and the two salt localities of Malgin and Jatta were visited, since the salt and gypsum frequently smell of petroleum and are sometimes bituminous. The folding in these places is severe and in Jatta becomes very complex. Although, on account of their clear exposures, these areas are of much scientific interest, the only economic value they have, from an oil prospector's standpoint, is that they are excellent examples of localities unsuitable for the retention of petroleum.

Pitchblende.

28. Both pitchblende and uranium ochre have been known for many years to occur at the Singar mica mines in the Gaya district,[1] although no serious attempt had been made to ascertain the amount available. Recently, however, prospecting has been carried out by Mr. H. E. Tiery in conjunction with Messrs. Moll, Schutte & Co., of Calcutta, and a certain quantity of pitchblende obtained. In view of the interest of the occurrence, Mr. R. C. Burton was instructed in October to visit the locality. I am indebted to Mr. Tiery and Messrs. Moll, Schutte & Co. for giving Mr. Burton every facility to examine their workings. Mr. Burton reports as follows:—

"The pitchblende occurs in a pegmatite, which crops out on a hill known as Abraki Pahar lying due east of Banekhap and rising two hundred feet above the surrounding alluvium. The pegmatite has a maximum width of forty yards and is exposed above the alluvium for a distance of approximately three hundred and fifty yards in a direction E. 20° S. It is intrusive along the bedding of fairly coarse-grained muscovite schists dipping at between 30° and 50° N., masses of the schist being also caught up in the body of the pegmatite. At the junction between the pegmatite and the schists, the latter contain tourmaline crystals in large quantity. This pegmatite has been mined for many years as a source of mica; before the mining for pitchblende commenced, the only indication of uranium on the surface consisted of small amounts of light yellow uranium ochre associated with triplite; but, as the pits were deepened, nodules of pure pitchblende were met with. At present six pits are being excavated by Mr. H. E. Tiery, and in five of them traces of uranium ochre have been found. Practically the whole

[1] T. H. Holland: *Mem., Geol. Sur. India*, XXXIV, p. 31.

of the pitchblende found (4 cwts.) has been obtained from a single pit, but small nodules have recently been found in another. The maximum weight of a nodule of pitchblende from the first pit is 36 lbs.

"The pitchblende occurs as rounded nodules distributed throughout certain basic segregations in the pegmatite, which are several feet in diameter. In these basic segregations the following minerals occur, but not always together:—white and yellow mica, triplite, ilmenite, tourmaline, pitchblende and uranium ochre; while columbite, zircon and torbernite have also been recorded.

"Of the above minerals triplite is the commonest and is generally associated with pitchblende and uranium ochre, being taken as an indication of the probable presence of these latter; whereas, if tourmaline is present in quantity at any particular part of the pegmatite, triplite seems to be either absent or present in only small amounts. In the largest segregation yet met with large masses of triplite formed the outer ring, while towards the interior pitchblende and uranium ochre became more plentiful; but as the segregation was quarried out large striated masses of ilmenite were revealed in association with the triplite. Quite close to the above another segregation occurred containing practically nothing but small books of white mica, showing the variability in composition of the pegmatite from place to place and the impossibility of prophesying where pitchblende may be found.

"The pitchblende occurs in several ways:—

(1) as rounded nodules easily detached from a matrix consisting of large blocks of triplite,

(2) as smaller nodules inside blocks of triplite,

(3) as nodules in the centre of enclosing nodules of felspathic material.

"The pitchblende in these cases is generally surrounded by a rim of uranium ochre. When the nodules of pitchblende have been removed, small amounts of uranium ochre are found distributed throughout the more acidic parts of the pegmatite surrounding the triplite; bags of this poorer material are preserved for future examination. As far as can be determined from the amount of excavation, which has up to the present been made, there is no definite alignment, for the segregations containing pitchblende are distributed at random in the pegmatite; and only systematic mining will reveal them; there seems no reason why they should not be found at depth.

"In addition to the above deposit triplite has also been found in a tourmaliniferous mica pegmatite, now being worked for mica, within the village boundaries of Gualatti about 1½ miles from Banekhap. This pegmatite has the same strike as that on Abraki Pahar and contains blocks of triplite fairly pure except for the presence of a little mica and quartz;

the triplite is rarely intimately intergrown with the other minerals of the pegmatite, but is generally in moderately pure blocks."

Water.

29. **Ajmer.**—At the request of the Agent to the Governor General in Rajputana Mr. Heron was deputed to visit Ajmer with a view to reporting on the possibility of the presence of artesian water in its immediate neighbourhood. The ground was examined carefully, and Mr. Heron came to the conclusion that the conditions were quite unsuitable for the occurrence of artesian water.

Wolfram.

30. **Marwar.**—During my visit to the Makrana marble quarries in September last, I was shown specimens of wolfram which were said to have been obtained from a hill in the neighbourhood of Degana railway station on the Jodhpur-Bikaner Railway, and I was requested by the Regent to make arrangements for the examination of the locality. I arranged therefore that Mr. Heron should visit the locality and investigate the occurrence. The result of his investigation showed that the wolfram occurred with quartz and biotite in veins traversing granite, and that, although not occurring in sufficient quantity to justify any great expense in erecting plants for working, it might perhaps be profitably exploited on a small scale by means of local labour.

GEOLOGICAL SURVEYS.

Bombay, Central India and Rajputana.

31. **Messrs. C. S. Middlemiss, H. C. Jones, A. M. Heron, and N. D. Daru.**—The party at work in these areas remained unchanged from last year, and was constituted as above. Mr. Middlemiss paid a visit of inspection and collaboration to Mr. Jones in the complicated region of Nimbahera district, Tonk, details of which will be found below (p. 28), and another to Mr. Daru on the frontier between Idar and Dungarpur States, during which latter, geological boundaries were adjusted along the border and various other points of detail discussed. Mr. Daru accompanied Mr. Middlemiss over some of the eastern parts of Idar where the sequence in certain critical sections is better exposed than in Dungarpur.

32. **Mr. C. S. Middlemiss: Idar State.**—Mr. Middlemiss was only able to devote a month to his survey in the southern and south-eastern parts of Idar, where some few patches of unfinished country were awaiting completion. The area was entered by way of Talod and Modasa,

Meghraj (lat. 23° 30′; long. 73° 33′) being the first important halting place, whence traverses were made in several directions. In addition to details of mapping further evidence was accumulated illustrating the threefold character of the formations which make up the older systems in this part, namely, the Aravalli system of older schists and gneisses, etc., the Delhi quartzite series lying unconformably above them, and passing upwards into the great phyllite formation of the eastern and south-eastern parts of Idar. Certain critical sections near Khercha were once more visited to illustrate the above unconformity of the quartzite series above the Aravallis. Elsewhere the Meghraj ridge of Delhi quartzite, that at Rampur, and the several digitations between Dev Mori and Od were all conclusively proved to be brachy-anticlines of that quartzite plunging beneath the Phyllite series, which eastwards appears to extend for long distances into Dungarpur (see last year's report, *Rec., Geol. Surv. India*, Vol. XLIII, p. 25).

33. A further continuation of the calc-magnesian rocks of the Dev Mori—Kundol section was found in the hollow in the hills of Delhi quartzite to the west of Kokapur (lat. 23° 31′; long. 73° 26′). This series, together with the Ghanta outcrop of steatite, probably constitutes one line of exposures, which would also appear from Mr. Daru's report to be continued in a N. N. E. direction across the Dungarpur boundary. Very little good steatite is exposed in the Kokapur section, but the area is almost entirely covered by quartzite débris from the surrounding hill-sides. Considerable quantities of magnesite are indicated and tremolite-calcite rock, as in the sections of Dev Mori and Kundol (see *Rec., Geol. Surv. India*, Vol. XLII, p. 52, 1912).

Mr. Middlemiss is now preparing an account of the geology of Idar State for publication.

34. **Mr. H. C. Jones: Indore, Gwalior and Tonk.**—Mr. H. C. Jones' sphere of work during a full season (November to April inclusive) lay in three closely related areas surrounding Neemuch town, namely, (1) the Rampura division of Indore State, (2) the country south of Neemuch in Gwalior territory, and (3) the Nimbahera district of Tonk. All fall within the 1″ = 1 mile standard sheets, Nos. 205, 206, 237, 238, 269 and 270 of the Central India and Rajputana Survey, and lie between lat. 24° 15′ and 24° 43′ and between long. 74° 30′ and 75° 58′.

Although a considerable tract of country was mapped by Mr. Jones in the Rampura division, as a northward continuation of his previous work carried out during the years 1907-1909, nothing of any special interest was observed beyond what had already been reported. In particular, owing to the prevalence of forest and the great height of the grass at the time of his visit, no further evidence was elicited tending to clear up the doubts still existing as to the actual Vindhyan horizons to which the Rampura quartzitic sandstone and the Suket shale should

probably be assigned (see *Rec., Geol. Surv. India*, Vol. XIV, pt. 4, and XXXVIII, 1908, p. 63).

35. The mapping of the second area lying to the south of Neemuch was a continuation westwards of the same earlier survey by Mr. Jones in order to join up with that done the year before by Mr. Heron in Partabgarh State. Good progress with the map here too has been made among those geological features, such as laterite, Deccan Trap and Intertrappeans, which are comparatively simple in their arrangement. But the western margin of the two areas, where the Suket shales or their covering of trap come into contact with Hacket's Delhis and Aravallis in Nimbahera district and in Udaipur, has for some time introduced difficulties of delineation and interpretation that have caused a serious check.

36. With the object of solving some of the problems involved, Mr. Middlemiss, during the early hot weather, joined Mr. Jones and spent a month with him re-surveying the tract south and west of Nimbahera, but with only partial success so far. Complete success cannot be hoped for until free access is obtained to the State of Udaipur, since Udaipur territory surrounds, and even encloses, these more complicated western areas of the Nimbahera district. Another disability is the long stretches of alluvium which bury much of the solid geology out of sight. As a result there remain only a few rather scattered and limited outcrops on which to base conclusions, and these present a bewildering multiplicity of strange rock facies.

37. Reserving all that is conjectural and provisional for discussion at a later period when more of the surrounding parts have been explored, the following few facts have been ascertained by the joint exploration of Messrs. Middlemiss and Jones. To the west of the meridian of Jawad, the Suket shales, in a set of gently undulating folds, become underlain by a particularly distinctive pale grey, compact and slabby limestone which is almost everywhere quarried into beautifully regular flags of from 10 to 12 feet long, by 3 to 4 feet wide, and 4 inches thick. These are used with great effect in the local buildings in Nimbahera and other towns, and are also exported to great distances by rail. This limestone which can be traced continuously from near Jawad to Nimbahera, and from there still further west at intervals as far as the undulating ground between Malan and Binota, is about 200 feet thick and passes downwards through a short thickness of impure purple limestone into several hundred feet of purple shale and then into a basement bed of purple grit, conglomerate and boulder-bed. The last, a few feet thick only, is composed of well rounded masses of quartzite, granite, gabbro and other rocks and was briefly referred to by Hacket (*Rec., Geol. Surv. India,* Vol. XIV, pt. 4).

38. Mr. Middlemiss considers that there can be no doubt whatever that in the strata exposed from the top of the Rampura sandstone scrap

down to this Binota basal conglomerate one passes through a generally conformable sequence, the members of which have now been separately delineated in detail on Mr. Jones' map. It has also been ascertained that this series with the boulder-bed at its base lies above rocks of various type, prominent among which are massive quartzites (Hacket's Delhis) at one place and thin-bedded shales at another,—facts which suggest an unconformity. Beyond this the survey of this tract is in a tentative stage; to the west and south-west of Binota there follow fresh sequences of limestones, shales, quartzite and conglomerate beds, but all differing so widely from the characteristic flaggy Nimbahera limestone and its associated shales and conglomerates, that for the present all that one can say is that it seems probable that they are really much older. This new series and their intrusive granite and basic rocks must await further examination.

39. **Mr. A. M. Heron: N. part of Jaipur State.**—Mr. A. M. Heron also spent a full season (latter part of October to end of April) in the field, being occupied during the whole of this time in continuing the survey of Jaipur. This he practically completed by his examination of the second half of the State to the north of Jaipur city (lat. 26° 56′; long. 75° 52′) and west of longitude 76° 10′, including the division of Amber, the Torawati and Shekhawati nizamats and the Khetri and Sikar States.

The area is included within the 1″=1 mile sheets, Nos. 224, 225, 255 to 260, and 284 to 289, and represents about 3,500 square miles. In this large tract the solid geology is mainly concentrated in the Shekhawati range of hills, which divides the country into two great plains to the north and south, and in the wild country to the east of meridian 75° 45′.

40. The Aravalli system is only very feebly, and sometimes doubtfully, developed at one or two localities as slender ridges of quartzite and schist dipping under the base of the Alwar series (Delhi system). Unlike the areas which adjoin Jaipur on the east and in which the geological sequence is much fuller, there are missing from the sequence in Jaipur both the Raialo limestone and quartzite at the base of the Alwar series, and likewise the Khushalgarh limestone and hornstone breccia at the base of the Ajabgarh series.

41. The remaining formations which alone are developed on a considerable scale are, therefore, the Alwar quartzite and the more argillaceous Ajabgarh or Mandan series. These present certain differences in their mode of occurrence from that which is customary in the more easterly area of Alwar State. Although at the surface the whole now presents a great array of interdigitating brachy-anticlines and synclines, the Ajabgarhs, instead of occupying subordinate synclinal valleys (outliers) folded into extensive massifs of Alwar quartzite, here constitute by

far the major portion of the exposed rocks, whilst the Alwars emerge from below them as four main anticlines or anticlinoria (inliers), two being in the Shekhawati and two in the Torawati hills respectively. Generally over the area, and more especially in the Shekhawati hills, the boundary line between the two formations is somewhat indefinite in consequence of the absence from this part of the country of the Khushalgarh calcareous series.

42. Along with the intense folding into isoclines which the rocks have sustained, there has been an increase in their metamorphism with the production of mica schists, actinolite schists, tremolite rock, and less often with the formation of staurolite, garnet and graphite. They are also intruded by (1) numerous and closely approximating sheets, sills and *lit-par-lit* injections of (1) amphibolite, (2) granite bosses, and (3) pegmatite veins, in the above order of time and in far greater quantity than in the eastern area of Alwar.

43. Among the details given in Mr. Heron's chapter on the igneous intrusions special attention is drawn to the amphibolites or traps. In composition these are now represented chiefly by the minerals hornblende and interstitial quartz with a granulitic structure, the result, as Mr. Heron thinks, of re-arrangement under crushing of the minerals of a rock of originally dioritic or doleritic composition. They appear to have preferred as avenues for their injection the more micaceous schists and conglomerates, but in the case of the limestone rocks the opinion is hazarded that "the thinner trap sills have been to some extent absorbed with mutual chemical reactions, resulting in the formation of actinolite, tremolite and epidote as streaks and knots in the crystalline marble." That the amphibolites are older than the granite or the pegmatite veins is shown by direct transgression of the latter across the amphibolite sills.

44. **Mr. N. D. Daru: Dungarpur, Sunth and Kadana.**—With the exception of the time spent in Idar State with Mr. Middlemiss, Mr. Daru was occupied in continuing the survey of Dungarpur State, and he also passed south into the small neighbouring States of Sunth and Kadana (Rewa Kantha Agency), where he made a beginning of operations. The country is of much the same geological type as that surveyed last year. Considerable progress in provisional mapping and description has been made, but as regards the final subdivision and correlation of the various members of the metamorphic series, Mr. Daru admits the necessity for a re-examination and re-description of large portions in the light of his recent experience in Idar. So far as may be at present summarised, it seems likely that the bulk of the country consists of the younger phyllite system as in the adjoining part of Idar. This is here and there interrupted by ridges of quartzite—probably the Delhi quartzite—which in turn ring round or partly enclose inliers of more highly metamorphic schists mixed with much igneous rock, the supposed equivalents of the older (Aravalli) system elsewhere.

45. A prominent feature is a number of bands and dyke-like assemblages of magnesian and calcareous rocks, namely, serpentine, talc, steatite, dolomite, magnesite and magnesian limestone, several of which can be identified with those described by Mr. Middlemiss from near Dev Mori, Kundol, Kokapur, etc., in Idar State. Some of the bands may be traced almost continuously from the one region to the other. From certain considerations, chief among which are the splitting of a band into two, their rapid variation in width, and the fact that they lie in contact with the younger phyllites as frequently as with the quartzites, Mr. Daru is inclined to ascribe to these rocks an igneous origin and to regard some form of actinolite rock as the parent.

Burma.

46. The party working in Burma during the field-season 1912-13 consisted of Messrs. Vredenburg, Datta, Cotter and Bion, and Sub-Assistant Sethu Rama Rau.

47. **Mr. H. S. Bion: Chindwin river.**—Mr. Bion was engaged on an examination of the auriferous gravels of the Chindwin river, while the remainder of the party were engaged on the continuation of the systematic survey of the Tertiary rocks of the Irrawadi valley.

48. **Mr. E. Vredenburg: Yenangyaung.**—Mr. Vredenburg spent the greater part of his time at Yenangyaung, where he was permitted to examine in detail the large collections of fossils belonging to the Burma Oil Company. He also visited some of the more important anticlines, and the volcanic areas of Popa in the Myingyan district and Shinmadaung in the Pakokku district. Mr. Vredenburg's observations have led him to believe that the fossils described by Dr. Noetling in his work on "The Fauna of the Miocene Beds of Burma" (*Pal. Ind.*, New Ser., Vol. I) include two separate faunas, an older and a younger, and that these two faunas are separated, one from the other, by an important unconformity extending throughout the Tertiary area in Burma. This unconformity is believed by him to occur within the Pegu series, dividing it naturally into an upper and a lower, the lower being the chief petroliferous group of beds and the upper being either non-petroliferous or only very sparingly so. So far as Mr. Vredenburg's work has gone, this unconformity is chiefly a palæontological one, and no conclusive evidence of a general physical or stratigraphical break has been adduced. The hypothesis of the occurrence of this supposed extensive unconformity has not met with general acceptance on the part of other members of the Geological Survey working in Burma, and it would, therefore, be premature to modify at present our classification of the Tertiary system of that province. Further field-work and detailed examination of the very extensive collections of fossils made during the last few years by the members of the Burma party will no doubt decide the question. At

present the more generally accepted belief is that the Pegu series, as might be expected in a series of estuarine or shallow-water deposits, contains a large number of small unconformities, none being of very great extent or of more than purely local importance.

49. **Mr. P. N. Datta: Myingyan and Sagaing.**—Mr. Datta continued the systematic mapping of parts of the districts of Sagaing, Myingyan, and Kyaukse. The rocks met with belonged entirely to the Pegu and younger series (Irrawadi series and alluvium).

50. **Mr. G. deP. Cotter: Minbu and Pakokku.**—Mr. Cotter worked during the early part of the season in the foot-hills of the Arakan Yoma to the west of Minbu, but, owing to a serious epidemic of malaria, which is said to have decimated some of the local villages, he was compelled to move to a less unhealthy locality, and he continued the survey of the lower beds of the Tertiary system (*Nummulitics*, Theobald) in the country between Pakokku and the Yoma. On returning to headquarters, Mr. Cotter devoted the recess to the detailed study of the fossils collected by him. These comprised nummulites and a considerable number of molluscs. The former have led Mr. Cotter to believe that the beds in which they occur and which he has named the 'Yaw stage' correspond in age with the upper eocene of Europe. A paper on the subject, in which he gives a description of some new species of nummulites, appears in the *Records of the Geological Survey*, Vol. XLIV.

51. Mr. Bion's work, which was entirely economic, has been referred to under *Gold*.

Central Provinces.

52. **Dr. L. L. Fermor: Korea coalfield.**—The Central Provinces party during the year consisted of Dr. L. L. Fermor, Messrs. H. Walker, C. S. Fox, R. C. Burton, and Sub-Assistant M. Vinayak Rao. During the earlier part of the year Dr. Fermor was engaged in a detailed examination of the coalfields in the Korea State. The rocks met with there, in addition to those of the Gondwana system, consisted of an Archæan crystalline group and Deccan trap. The crystalline rocks show a striking similarity to those forming the core of the Satpura range in the Chhindwara district, and Dr. Fermor is inclined to regard the crystallines of Korea as merely the extension of the axis of the Satpura range. The representatives of the Deccan trap are chiefly of an intrusive nature and consist of dykes of dolerite of various degrees of coarseness with or without olivine, the most remarkable member of the group, however, being an intrusive sill of very considerable extent occurring immediately to the north of the Kurasia field and partly overlying it. The rock of this sill is coarsely crystalline in the

centre, and finer in its upper and lower portions, the margins consisting of basalt from 1 to 3 feet thick.

53. **Mr. C. S. Fox: Chhindwara.**—Mr. C. S. Fox continued his survey of Chhindwara district, working chiefly in the Chhindwara and Jagir tahsils. The general conclusions arrived at during the previous year were confirmed by the work of the past season, and a considerable amount of new information has been acquired regarding the crystalline rocks which, according to Mr. Fox, fall into three main zones: (1) a zone to the south of the latitude of Lawaghogri, in which the gneisses and schists appear to be obviously older or metamorphosed igneous rocks of granitic character; (2) a zone above Lawaghogri, extending about to the latitude of Chhindwara town and consisting of a group of gneisses and schists of which the origin is obscure. They cannot be regarded as older igneous rocks, nor can they satisfactorily be regarded as of sedimentary origin; (3) the third zone is constituted by a belt, occasionally 8 miles in width, running through Chhindwara town and consisting of coarse porphyritic intrusive granites with which are intimately associated dykes of a medium grained pink granite, a rock found also in the other zones. Basic rocks are also found in each of these zones and are represented by diabase, epidiorite and amphibolite. Locally pyroxene is developed at the expense of hornblende.

54. The strike of the foliation throughout these zones is markedly regular, ranging from E. 10° S.—W. 10° N. to E. N. E.—W. S. W., and Mr. Fox is inclined to believe that the country between the Sausar tahsil and the alluvial flats of the Narbada valley now represents the worn-down base of an old mountain system. As regards the Deccan trap, Mr. Fox finds that the trap dykes become more and more numerous as the neighbourhood of the Chhindwara coalfields is approached. The dykes become larger and more continuous, one having been traced for nearly 45 miles continuously and having a width of 30 yards. Information as to the trap-flows of Chhindwara has been made more extensive and more precise; further evidence has been obtained of the overlap on to the crystalline rocks of the last flow but one over the basal flow, whilst an additional, or fifth, flow was observed in the neighbourhood of Changoba at Narsala hill; two more, a sixth and a seventh, apparently existing near Rajdongri; the two last, however, are very thin and their Intertrappean horizons not well marked.

55. **Mr. R. C. Burton: Seoni.**—Mr. R. C. Burton was engaged on the survey of the Seoni district, the area examined falling roughly into two parts—(1) the trap and laterite plain north of the ghats, and (2) the plain of metamorphic rocks to the south of the ghats. The former plain is approximately 2,000 feet high, and appears to consist of trap-flows covering an old ridge of gneissic rocks forming the continuation of the Satpura range. From the southern edge of the plateau thus

formed the ground slopes gradually down to the lower plain consisting of metamorphic rocks with some isolated hills reaching the 2,000 feet level. Amongst the rocks found in the area examined during the season the chief are: laterite, trap, Lameta beds, various forms of gneiss and granite, and a group of rocks, probably of Dharwar age, represented by crystalline limestone, pyroxene gneiss, pyroxenite, amphibolite, quartzite and mica-schist. The laterite is chiefly of the usual high-level type and formed *in situ* by the weathering of the underlying trap. In certain cases, however, Mr. Burton has reason to believe that some of the high-level laterites owe their origin to deposition in a lake basin in the trap, since he has found sandstones interbedded with the laterite. The evidence, however, is not entirely conclusive. Occasionally beds of lithomarge are found intervening between the laterite and the underlying gneiss or trap. This lithomarge is regarded by Mr. Burton as a product of alteration *in situ* of the rock on which the lithomarge is now found resting.

56. In the *General Report* for the year 1912 reference was made to the discovery by the Central Provinces party of basalt dykes of Deccan trap age traversing the Archæan rocks. Several new dykes of the kind were noticed by Mr. Burton. They fall naturally into three groups, one at Suktara, another at Thanwurjhori, and a third at Katiapar. These were found cutting through both gneiss and trap and are regarded as indicating the position of the fissures through which the Deccan trap was extruded. The only outcrops of Lameta age were found in the neighbourhood of Khammaria, where they consist of beds of sand and sandstone having a maximum thickness of 20 feet and overlying silicified gneiss.

57. From a study of the Satpura range in Seoni district Mr. Burton is not disposed to agree with the statement made by the late Mr. E. J. Jones in *Memoirs, Geol. Surv. India,* Vol. XXIV, to the effect that the small coalfield of Sirgora constitutes practically the eastern edge of the Gondwanas in this area. He rather inclines to the belief that this belt of Gondwana rocks may extend from Chhindwara beneath the trap of Seoni and Mandla, in which case it might be reached by a boring at Lakhnadon. More extensive surveys, however, will be necessary before the probabilities of the occurrence of the coalfield beneath these trap areas can be more clearly estimated.

58. Amongst the older crystalline rocks the silicified and calcified gneisses, referred to in previous reports, were found in several places, being occasionally associated with Lametas.

59. **Sub-Assistant M. Vinayak Rao: Seoni.**—Sub-Assistant M. Vinayak Rao continued his mapping along the boundary between the Deccan trap and the older crystalline rocks of the Seoni district. Certain areas, which had been only roughly mapped during the previous field

season, were re-visited. Mr. Vinayak Rao also records the occurrence of at least six flows of trap.

Kashmir.

60. **Messrs. C. S. Middlemiss and H. S. Bion.**—During the hot-weather season in Kashmir, several of the new contoured 1″=1 mile degree sheets of the Survey of India became available for delineating the geology. In adjoining areas where these were not yet ready tracings of the incomplete maps, supplied in advance of publication by the courtesy of the Survey of India, were used with great advantage for field purposes. With the help of these beautifully executed sheets good progress was made by Messrs. Middlemiss and Bion, both in the direction of fresh additions to the revised geological survey now in progress and also in transferring the work of the last few years to these new sheets—checking it where necessary by fresh traverses. Mainly because of the greater attention to detail necessitated by the use of these larger and more accurate maps, the anticipation in last year's report that the valley of Kashmir proper, that is to say, the area within the Jhelum drainage, would be completed this season, has not quite been realised.

The following shows the present state of progress of the survey:—completed, degree sheets 43 J/7 and J/12; mostly surveyed, degree sheets 43 J/3, J/8, J/11, J/16, K/9, N/4, and O/1; partly surveyed, sheets 43 J/4, K/13, together with parts of tracings of 43 K/14, N/8, O/2, O/5 and O/6.

61. **Mr. Middlemiss: Pir Panjal, Kazi Nag, etc.**—Mr. Middlemiss was mainly concerned in extending the survey to the north-west of the Nil Nag—Tata-Kuti line of section (described in *Rec., Geol. Surv. India*, Vol. XLI, pt. 2, p. 120) along the Pir Panjal and Kazi Nag (Kajnag) ranges and along the Karewa country fringing the valley of Kashmir at the foot of those ranges. The older series of rocks forming the backbone of the hills is composed of vast thicknesses of Panjal Trap with Agglomeratic Slate below and presumed Gondwanas above. The marine Permian and Trias with their characteristic fossil zones were found to be not continued much beyond the neighbourhood of Tosh Maidan.

62. The Kazi Nag intrusive granite (ordinary Himalayan muscovite-biotite-granite, somewhat foliated) which is also represented by very small intrusive masses on the south side of the Baramulla gorge near Gulmarg, has pierced this old series of rocks, metamorphosing them to phyllites, chlorite schists and epidotised forms of the Panjal Trap with lenticular augen. The north-north-east edge of the Kazi Nag mass appears to be a fault, bringing up locally to the north the older Slate Series along the higher reaches of the Mawar river. These slates present the strange appearance of being less mineralised than the much younger

Panjal Trap, etc. The line of this fault is probably co-extensive with that of the Mahadeo-Nagberan-Aru fault, which elsewhere was simultaneously traced by Mr. Bion, and thus embraces a length of at least 70 miles.

63. The Karewas have afforded unexpectedly interesting features. Chief among these is the further evidence for local lines of sharp folding, with dips of about 40°, which relieve the monotonously regular dip of 18°—20° and even less, which characterises them as a whole, and thus repeats the feature already described at Eosu (Yus, of the new maps) Marg (*loc. cit.*, p. 121). Other features brought to light are the existence of small outlying patches of Karewas at the great height of 11,000 feet, some being actually on the Pir Panjal watershed, and so situated and petrologically constituted that, taking into consideration the dips of 20° of the main mass of the Karewas, the conclusion Mr. Middlemiss finds inevitable is that the Karewas as a whole must have swept in a great arch, varied locally by sharp monoclinal puckers, entirely over the older rocks of the crest of the Pir Panjal before they became all but removed by denudation from the upper part of the arch. It follows that the Pir Panjal range must have about doubled its height by tilting and flexuring since the time when the oak and the alder tree flourished in this region, and became preserved in the Karewa deposits (*loc. cit.*, p. 122). A revised estimate for the total thickness of the Karewas, made possible by the new maps, is 3,000 feet as against 1,400 feet of previous estimates.

64. Although the old grass-covered moraines of the north-east slopes of the Pir Panjal, attributed to the glacial epoch, generally extend to the 10,000 feet level as now determined by the new contoured sheets, they also tail-out down-stream as partially redistributed long processes to as much as 3,000 feet lower (7,000 feet actual altitude), whilst some few very large erratics of Panjal Trap, 18 yards across, are found even at 6,500 feet, as at Arigam village, where owing to the extremely gentle slope of the country no other transport than ice can be imagined as operative.

65. During the latter part of the season Mr. Middlemiss continued the mapping of the neighbourhood of Vernag and the Banihal pass, where during the previous season certain Jurassic fossils were collected by Mr. Bion and himself in a series of limestones, shales and rusty-coloured quartzitic sandstones which follow normally above the topmost Upper Trias beds. The area was completed so far as the new maps go into connection with the Golabgarh area, with the exception of a small portion south-west of Shupiyan. The well-marked fault between the Banihal pass and Vernag was traced *viâ* Kulgam and Shupiyan in a W. N. W. direction to connect up with the Tosh Maidan fault (*loc. cit.*, map and p. 129) and the high-dipping Karewas of Eosu Marg (Yus Marg), a distance of at least 60 miles.

66. **Mr. Bion: tract N. of Srinagar and Pahlgam.**—Mr. Bion carried out an entirely separate and arduous piece of detailed mapping in the high mountainous region lying to the north of a line joining Srinagar and Pahlgam (Pailgam) and including the Dachhigam State Preserve, the whole of the upper reaches of the Lidar river and the neighbourhood of the famous Kolahoi peak. The rock series involved is a highly complicated folded mass of almost the whole of the fossiliferous series from the Slate Series to the Upper Trias, and is an extension northwards and eastwards of the sequence already mapped and described by Mr. Middlemiss (*Rec., Geol. Surv. India,* Vol. XL, pt. 3, p. 206, with map). As Mr. Bion is putting his work into a form suitable for early publication, it will be unnecessary to do more than indicate briefly a few of the more interesting results that have come to light from the very complete palæontological collections made by him under conditions of considerable difficulty and high altitude. The Agglomeratic Slate series was again found to be fossiliferous at several horizons, the fossils, as in the case of the Marbal valley, being identical with those from the Fenestella Shales. They include especially *Syringothyris Lydekkeri* Dien. and a *Camarophoria* allied to *C. Purdoni* Dav., *Fenestella* and, rarely, *Protoretepora.*

67. With reference to the Lower Trias, Mr. Bion's remarks are of such importance as to be quoted in full. He says: "About 20 feet above the base of the black shales there is a layer of calcareous nodules from which many specimens of *Otoceras* have been obtained associated with almost all the other members of the fauna of the Otoceras beds of the Central Himalaya. Good collections have been obtained from Nagaberan in the Dachhigam State Rakh and from the Pahlgam-Aru basin. Some thirty feet above the Otoceras layer there is another fossiliferous horizon characterised by *Ophiceras* from which one specimen of *Otoceras* was also procured, but the rest of the black shale division seems to be barren. A surprising element in the fauna of the basal Otoceras layer is furnished by the presence of the genus *Productus,* of which three specimens have been obtained from near Pahlgam. In spite of this Permian element I consider that the fauna of the Otoceras beds of Kashmir has a decided triassic aspect.

"The black shale division passes up, by a gradual increase in the calcareous intercalations, into some 300 feet of thin-bedded blue limestones which almost invariably break into two well-marked crags. The lower of these crags is absolutely barren, but the upper one, which contains subordinate shales, has yielded fossils. The fauna obtained by C. S. Middlemiss from the Guryul ravine came from these upper beds, and while examining the section at Pastannah from which the same observer obtained his Ophiceras fauna, I was fortunate enough to ascertain that this horizon also occurs in the upper part of these limestones. It now becomes evident that the Guryul ravine fauna is on practically the

same horizon as the Ophiceras horizon of Pastannah, a fact strongly at variance with the conclusions arrived at by Professor Diener as a result of his examination of C. S. Middlemiss' collections. Professor Diener referred the Pastannah fauna to the horizon of the Otoceras beds of Spiti and the Guryul ravine fauna to that of the Hedenstrœmia stage of the same area (*Pal. Ind.*, New Series, Vol. V, Mem. I, p. 120). It is now evident that the Pastannah fauna occurs at an horizon some two to three hundred feet above the Otoceras beds proper, and that there is very little difference of horizon between it and that of the Guryul ravine."

In conclusion Mr. Bion is strongly of the opinion that the Pastannah fauna is very nearly allied to that of the Otoceras beds but a slightly different and younger variant, while the Guryul ravine fauna is most nearly allied to that of the Meekoceras beds, as was originally supposed by Mr. Middlemiss.

68. With reference to glacial features, Mr. Bion finds two sets of moraines, the one recently left by the last retreat of the ice, and the other a relic of an older glaciation, the moraines of which are now covered with grass and even small trees. The ice during the older and maximum glaciation certainly reached down to the 8,000 feet level as shown by striated pavements and moraines, and it may well have reached as low as 7,000 feet.

GEODESY.

BY

LIEUTENANT-COLONEL G. P. LENOX-CONYNGHAM, R.E.,
Superintendent of the Trigonometrical Survey.

TRIANGULATION.

Kashmir.

Indo-Russian Connection.—The year 1913 was notable in seeing the conclusion of the Indian portion of the connection between the triangulations of India and Russia. It is hoped that the connection between the Russian work in Asia and in Europe will be completed before very long, and when this has been done the first direct connection of the triangulation of India with that of Europe will have been accomplished.

The inception of this work was in great measure due to the action taken at the International Geodetic Conference of 1909, when a resolution was passed calling attention to the great desirability of a connection between the Indian and Russian systems and expressing the hope that the Governments concerned would look favourably on the idea.

The link now completed has been made in the face of such very great difficulties that it has not been possible to adhere to the rigorous methods of Principal Triangulation, nevertheless a very fair degree of precision has been attained and a result of great value secured.

The Indian link, which extends from near Gilgit in latitude 36° to the two Russian stations of Kukhtek and Sarblock in latitude 37° 18′, has had stupendous obstacles to surmount, and three years of effort, first in the reconnaissance and then in the execution of the work, have been required for its completion. Two or three officers have been employed on it in each of the years 1911, 1912 and 1913, during the only possible working months, namely, June, July and August, exclusive of the time taken in going and returning. Several different routes were successively reconnoitred before a feasible one was discovered, and even on the one which was eventually selected many of the stations were very difficult of access. The length of the link is about 140 miles, though the direct distance from the station of origin near Gilgit to the Russian station of Sarblock is less than 120: this increased length is due to the triangulation having to follow a tortuous course in order to avoid the insurmountable barriers that many parts of the ranges present. The average

length of the sides of the triangles is 8·6 miles and the average height of the stations 16,200 feet. The highest station was over 19,000 feet, and the lowest over 13,000. The whole work was one of considerable danger and cost us the lives of Lieutenant Bell, R.E., and three Khalasis. Difficulties of transport prevented the use of anything larger than 6-inch theodolites. The mean triangular error for most of the work was below 3″, but it rose to over 7″ for 6 triangles where opaque signals had to be used, and where conditions were particularly difficult, their stations averaging nearly 18,000 feet in height. The link series consists of seven quadrilaterals with observed diagonals, two tetragons with central points, and eleven single triangles.

Orissa and Madras.

The Sambalpur Principal Series.—During the season 1913-14 this series was extended, still following the meridian of 84°, through parts of the districts of Ganjam and Vizagapatam, till connection was made with the stations Deodongar and Himagiri of the East Coast Series, which are situated in latitude 18° 52′, on two of the higher peaks of the Eastern Ghats, 33 miles from the sea. Observing was commenced on the 12th November, but on account of bad weather little progress was made till the 24th. After this, work continued with little interruption till the last station was completed on the 7th January. An astronomical azimuth was observed at Deodongar H. S. in latitude 18° 55′. The observations were made with Messrs. Troughton and Simms' three-microscope, 12-inch, micrometer theodolite No. V. The average triangular error of the season's work is 0″ ·119, the maximum being 0″ ·316. The total length of the Sambalpur Series, which runs along meridian 84°, and extends from the Calcutta longitudinal to the East Coast Series, is 31 miles; it consists of 12 figures covering an area of 9,028 sq. miles. The average triangular error of the 51 triangles is 0″ ·293, three errors only being above 1″, the largest of which is 1″ ·526. The whole work took one observer 11 months to complete.

A comparison of the old and new values of the junction stations of the Sambalpur and East Coast Series are given below:—

—	—	East Coast Series (1857-58).	Sambalpur Series (1913-14).	Difference.
Deodongar H. S.	Latitude . .	18° 54′ 32″·37	18° 54′ 32″·51	+0″·14
	Longitude . .	84° 3′ 35″	84° 3′ 35″·80	−0″·04
	Azimuth . .	72° 5′ 33″·76	72° 5′ 36″·94	+3″·18
	Height . .	4,534 feet	4,534 feet	*Nil.*
	Side in feet . .	99,839·4 feet	99,838·8 feet	−0″·6 ft.

—	—	East Coast Series (1857-58).	Sambalpur Series (1913-14).	Difference.
Himagiri H. S.	Latitude	18° 49′ 27″·29	18° 49′ 27″·46	+0″·17
	Longitude	83° 47′ 06″·69	83° 47′ 06″·65	−0″·04
	Azimuth	252° 00′ 13″·90	252° 00′ 17″·09	+3″·19
	Height	3,709 feet	3,704 feet	—5 ft.

Central Provinces and Bombay.

The Buldana Secondary Series.—The building of stations for this series was commenced, and referred to in last year's report, under the name of the *Akola Series*, its object being to meet current topographical needs. Observations were commenced during the past season by the principal detachment, after completion of the Sambalpur Series, and were carried southwards through a distance of 104 miles, along the meridian 76° 30′, between latitudes 20° 12′ and 21° 43′. This constitutes a little more than the Northern half of the series, and the observations included 18 single triangles covering an area of 1,431 square miles. The country passed through in Berar is flat, without any prominent peaks. The sides of the triangles are consequently small, and the work of laying out the series was slow and difficult. The observations were made with an 8-inch micrometer theodolite by Troughton and Simms. The average triangular error of the 18 triangles is 0″ ·437, the maximum error obtained being 0″ ·98.

Central Provinces and Central India Agency.

The Ashta Secondary Series.—This series is to connect the Khandwa Series, completed last year, with the Karachi Longitudinal, along the meridian 76° 30′ and between latitudes 22°—24°, to supply framework for current topography.

The work was done in the latter half of the season by the detachment which had been employed in completing the Bombay Island traverse. Of the total length of 136 miles, nearly 100 miles were completed, including 16 stations comprising 14 triangles. The remaining stations were built and will be observed at next season. The instrument used was an 8-inch micrometer theodolite by Troughton and Simms; the average triangular error was 1″ ·07, the largest being 3″ ·07.

Hyderabad State, Bombay and Madras.

The Naldrug Secondary Series.—This series is to afford points for topography along meridian 76° 30′, between latitudes 15° 30′ and 18°. It was carried due south from the Bombay Longitudinal Series down to

latitude 15° 30′, where it turns East to connect with the Great Arc Series. The length was 265 miles covering an area of 4,429 square miles. The number of stations observed at was 32, comprising 32 triangles. An 8-inch theodolite by Troughton and Simms was used; the average triangular error was 2″ ·16, the largest error being 4″ ·94. The discrepancies found on closing with the Great Arc Series were, 2 feet in length of side, 10 feet in height, nearly 18″ in azimuth, and an average of 0″ ·22 in the co-ordinates of the two stations.

Assam.

Naga Hills and Jaintia Hills Series.—The Naga Hills Series is that referred to in last year's report as the Manipur Series, and the connection with the old Manipur Series, consisting of 9 triangles, has been completed. After this the detachment worked westwards from the Naga Hills Series along the parallel 25° 30′ to make connection with the Jaintia Hills Series, of which this new work thus forms a continuation.

It was found impossible to complete this latter connection during the past season owing to haze, and after waiting some weeks for clearer weather the attempt was abandoned.

Altogether 20 triangles were observed, including 17 stations, and an area of 2,570 square miles, in both these series. The average triangular error was 1″ ·23, the largest being 4″ ·26. The instrument was a 12-inch micrometer theodolite by Troughton and Simms.

It is hoped that these Assam connections, together with the result of the Khasi Garo Hills Series, reported last year, will afford the basis for some definite conclusion as to how far the trigonometrical stations were disturbed by the great Assam earthquake of 1897.

Bombay.

Bombay City Traverse.

The main traverse network has been completed. This, together with the triangulation reported upon last year, is to form a basis for the detail traverses which are now being carried out by the Superintendent of the Bombay City Survey.

The season's work occupied 2 observers and staff for 3 months, during which time 5 triangulation and 32 permanent traverse stations were fixed. The traverse work involved 307 theodolite stations and 32 linear miles of measurement. Where the roads were open and free from traffic an outturn of nearly a mile a day was found possible, but the average, including congested areas, was under ½ mile per working day.

Twenty readings were taken for each horizontal angle with an 8-inch micrometer theodolite, and linear measurements were made with steel tapes laid along the ground under a uniform strain of twenty pounds,

Daily comparisons of tapes with standard were made, and the temperature of each third tape recorded at the time of measurement. Corrections for daily variations in length and for temperature were thus applied to each measurement.

ASTRONOMICAL LATITUDES.

During the field season of 1913-14 astronomical latitudes were observed by Talcott's method at 10 stations on the Malabar coast and along the Western Ghats; the most northerly station being Parnera H. S. in Surat District, and the most southerly Kumbhari H. S. in North Kanara. Observations were also made at 4 stations in the neighbourhood of latitude 30°, in the Saharanpur, Bijnor, Najibabad and Garhwal Districts, in order to obtain extra data in a locality which is much under discussion in connection with the deficiency of gravity at the foot of the Himalayas. The results of the observations have not yet been computed and must be held over for discussion in next year's report.

PENDULUM OPERATIONS.

During the season 1913-14 measurements of gravity were made at 10 stations along a line extending from Alibag to Pali (Marwar). Observations were made at Colaba, which lies between the two first stations of Alibag and Daman, in 1904, and therefore this station has been included for the sake of comparison in the summary of results of the season's work.

Since last year's report certain alterations have been made in the computations. Previously it has been the practice to apply the corrections for height of station and for surface masses to the *observed* value of gravity g, thus obtaining a value of gravity at sea-level, g_0'' which can be compared with the theoretical value γ_0 at sea level in the latitude of the station. Now and in future these corrections will be applied to the *theoretical* value γ_0, so that the observed value can be compared directly with that obtained by calculation. Of course whichever method is adopted the residuals, $g-\gamma_0$ (with the appropriate suffixes), remain the same.

Necessarily the suffixes employed have required alteration and the tabular summary requires some explanation. Column 5 "Correction for height" shows the correction for height alone, neglecting all masses above sea level. Column 6 allows for all masses above sea level according to Bouguer's method, and includes an orographical correction where necessary to allow for the departure of the actual land surface from an indefinite plain at the height of the station. Column 7 allows for all surface masses and their compensation according to Hayford's

theory of isostasy. $_A$ shows γ with the height correction applied: γ_B shows it with the height and Bouguer corrections applied, while γ_C shows it with the height and Hayford corrections applied. The three last columns give the residuals showing whether gravity as observed is in excess or defect of the value obtained by each of the three methods. It should also be noted that the mean surface density of the earth is now being taken as 2·67 instead of 2·8 and the mean density of the earth as 5·576 instead of 5·6. This change reduces all former values of the Bouguer corrections by about $\frac{1}{23}$rd part.

Further the formula for γ_0 has been altered. While formerly Helmert's old formula $\gamma_0 = 978{\cdot}0\ (1 + {\cdot}005310 \sin^2\phi)$ was used, now Helmert's 1901 formula $\gamma_0 = 978{\cdot}030\ (1 + {\cdot}005302 \sin^2\phi - 0{\cdot}000007 \sin^2\phi)$ is being used. This change increases the value of γ_0 by amounts varying in India from 0·029 to 0·021 dyne.

The chief feature of note in the season's results is the large change in gravity between Colaba and Alibag, *viz.*, over 0·060 dyne within a distance of some 15 miles. These stations are both on the coast and there is nothing in the topography to account for so great a change. It has therefore been decided to extend the investigation by measuring the gravity at a group of stations in that vicinity in the course of the next field season.

The investigation of the isostatic correction to gravity results on the Hayford hypothesis has now been extended to some 80 stations and is being continued. A professional paper by Captain H. J. Couchman, R.E., dealing with the pendulum observations from 1907 to 1913 and discussing the results of the application of Hayford's theory to the observed value of gravity in India is now in the press.

Summary of results, 1913-14.

Station.	Latitude.	Longitude.	Height above M. S. L.	Corrections for height.	Corrections Bouguer.	Corrections Hayford.	γ_0	γ_A (free air).	γ_B (Bouguer)	γ_C (Hayford).	g	$g-\gamma_A$	$g-\gamma_B$	$g-\gamma_C$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	° ′ ″	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.	Dynes.
Alībāg . .	18 38 30	72 52 10	12	—·001	·000	—·002	978·557	978·556	978·556	978·554	978·551	—·005	—·005	—·003
Colāba * . .	*18 53 47*	*72 48 47*	*34*	*—·003*	*+·001*	*·000*	*·571*	*·568*	*·569*	*·568*	*·631*	*+·063*	*+·062*	*+·063*
Damān . .	20 24 45	72 50 5	15	—·001	+·001	—·006	·658	·657	·658	·651	·700	+·043	+·042	+·051
Surat . . .	21 10 5	72 48 5	30	—·003	+·001	—·005	·703	·700	·701	·695	·727	+·027	+·026	+·032
Broach . .	21 42 5	72 59 0	51	—·005	+·002	—·006	·736	·731	·733	·725	·740	+·009	+·007	+·015
Baroda . .	22 18 35	73 11 5	109	—·010	+·004	—·007	·774	·764	·768	·757	·749	—·015	—·019	—·008
Ahmadābād .	23 1 20	72 33 55	156	—·015	+·005	—·003	·820	·805	·810	·803	·837	+·032	+·027	+·035
Deesa . .	24 15 20	72 11 30	465	—·044	+·016	—·007	·901	·857	·873	·850	·902	+·045	+·029	+·052
Abu . . .	24 35 40	72 43 0	3,836	—·359	+·123	+·085	·924	·565	·688	·650	·679	+·114	—·009	+·029
Erinpura . .	25 8 55	73 3 35	872	—·082	+·029	—·007	·962	·880	·909	·873	·896	+·016	—·013	+·023
Pali, Mārwar .	25 47 30	73 19 25	719	—·067	+·024	—·010	979·007	978·940	978·964	978·930	978·950	+·010	—·014	+·020

* Observations made in 1904.

N. B.—These results are not final, and are therefore subject to slight alterations.

LEVELLING OPERATIONS.

During the year 1913-14, the following lines of precise levels were run:—

(a) *In the Punjab.*

Solon to Simla with branch lines to "Prospect Hill" and "Jakko."

Jagadhri *viâ* Ambala to Ludhiana (Revision). The line was originally levelled in 1860-62.

Ferozepore to Lahore (Revision). This line was first levelled in 1866-67.

(b) *In Sind and Baluchistan.*

Jacobabad (Sind) *viâ* Sibi and the Bolan Pass to Quetta.

(c) *In Bengal.*

Mymensingh to Dacca.

Panchuria to Poradaha (Revision). This line was originally done by single levelling in 1899-1900.

Howrah to Champdani Police out-post. This forms part of the line which will next season be carried on to Benares

Tindharia to Darjeeling with branch lines to Lebong and Tukdah.

In addition to the above, the crossings of the Brahmaputra at Dhubri, and of the Meghna, Lakhya, Dhaleswari and Padma rivers were repeated: for the first four crossings, vertical angles were observed, and for the last the "target" method was adopted. The distances across being respectively 4,530, 900, 440, 900 and 2,400 yards.

(d) *In Burma.*

Magwe *viâ* Natmauk to Taungdwingyi. This completes the line from Prome to Magwe, and closes the first circuit in Burma.

Taunggyi *viâ* Thamakan and Kalaw to Thazi.

Mokpalin to Amherst, *viâ* Martaban and Moulmein, crossing the Salween river at Amherst by vertical angle observations, the distance across this river being 3,080 yards.

Of these lines of levelling two have been run from the plains to the hills, *viz.*: Thazi to Taunggyi in Burma and Jacobabad to Quetta in the Central Brahui Range, Baluchistan; and two are extensions further

into the hills of lines emanating from the plains, *viz.* :—Solon to Simla, and Tindharia to Darjeeling, both in the Himalayas.

The present system of levelling of precision in India is that initiated by General Walker in 1858. It is "Simultaneous double levelling." In this system each line is observed by two levellers working independently under practically identical conditions. The progress of work on such lines is not continuously in the same direction. Each line is divided into sections of 1 to 4 miles in length, as is convenient for each day's work, and the total length of the sections levelled in one direction is made equal to the total length of the sections levelled in the opposite direction.

On the whole this system has stood the test of time and has given very satisfactory results.

At the International Geodetic Conference of 1912, a resolution was passed that in future there will be a new category of levelling to be called "Levelling of high precision," and that to qualify for this category each section of a line of levels must be levelled twice, in opposite directions, on dates as widely different as possible, and that the errors, calculated according to certain formulæ, must not exceed certain limits.

The main object of this new system is to evaluate the systematic or cumulative error dependent on the direction in which the levelling proceeds. In "Simultaneous double levelling" this error cannot be evaluated, because each section is worked in the same direction, and not fore and back, by both the levellers. It is, however, eliminated from the final result by the system of levelling alternate sections in opposite directions.

During the past season two lines were worked on the new system of "fore and back double levelling," *viz.* :—

Ferozepore to Lahore; and Jacobabad to Quetta.

Each section was, however, levelled on the same day, a plan which though not in accordance with the above resolutions has several points in its favour. Henceforward the system of "fore- and back- double levelling" will always be employed and it is hoped that the work will attain the accuracy required for its inclusion in the new category.

TIDAL OPERATIONS.

During the year tidal registrations by automatic gauges have been continued at the following ports:—

Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein and Port Blair.

There were no serious interruptions in the working of the tide-gauges, except at Madras, where the tidal registration came to a standstill at the end of July 1913 owing to the passage between the sea and the observatory well having become blocked with sand. It was found practically impossible to clear the passage. It was therefore decided, in consultation with the Chief Engineer of the Port, to remove the tidal observatory to a more suitable site. The new Observatory was built in February 1914 and in it the tide-gauge has since been working satisfactorily.

Comparing the discrepancies between the actual registrations of the times and heights of high and low water and the predicted values for the same in 1913, with those of 1912, it is found that the accuracy of the predictions for 1913 has been practically of the same standard as that for 1912. The predictions for times in 1913 have slightly improved at Karachi and Rangoon, but have become slightly worse at Moulmein and Port Blair.

In addition to the automatic tidal registrations, observations of high and low water were taken on tide poles during daylight at Bhaunagar, Chittagong and Akyab, where tidal registrations by automatic tide-gauges were stopped some years ago. The object of these tide pole observations is to test the accuracy of the predictions which are still being based on the automatic tidal registrations taken before the dismantling of the gauges.

OPERATIONS AT DEHRA DUN.

During the last two years opportunities have occurred for studying the irregularities of the geoid in the neighbourhood of Dehra Dun. The height of Mussoorie above Dehra deduced by the ordinary formulæ from numerous observed vertical angles is in excess of that found by spirit levelling by somewhat more than 3 feet (*see* Prof. Paper No. 11, p. 7). When proper attention was paid to the deflection of the plumb line and the refraction was computed in accordance with the conditions imposed by the known decrease of refraction with height, the value obtained from the vertical angles agreed more closely with the height found from spirit levelling corrected for the rise of the geoid relative to the spheroid: and the resulting discrepancy then amounted to 1·94 feet (*see* Prof. Paper No. 14, p. 22). To calculate the rise of the geoid relative to the spheroid a detailed knowledge of plumb line deflections is necessary—more than was available at the time referred to. The discrepancy of 1·94 feet could be explained by an additional rise of the geoid of that amount; and this suggested that the deflections of the plumb line at points intermediate between Dehra, Rajpur and Mussoorie, which are the only places where observations had been made, might well be expected to exceed the values which might be found by interpolation. With this

in view a series of stations was fixed between Dehra, Rajpur and Mussoorie and latitude was observed at each. In addition, the latitude of Nag Tiba was observed. This was of importance as it is the nearest point from which the snow-peaks of this portion of the Himalayas have been observed. All these observations were made in season 1912-13.

In the following season a series of azimuth observations was made with a view to finding the other component of the deflections. In selecting stations it was possible to take advantage of the new latitudes which indicated where the deflection was likely to be irregular.

The results of the two seasons' observations are now shown in tabular form. The table includes also the old values of deflection for convenience of reference, but the new work is shown in italics.

Station.	Latitude.	Longitude.	Deflection of Plumb Line.			
			In Meridian towards North.	In Prime vertical towards East.	Resultant.	Direction. East of North.
	° ′ ″	° ′ ″	″	″	″	°
Dehra Dūn .	30 19 28·73	78 3 22·12	37·5	22·7	43·8	31·2
III	30 21 46·61	78 4 7·39	*41·0*			
IV	30 22 8·93	78 4 30·87	*42·2*			
V	30 22 51·83	78 5 21·38	*44·4*			
VI	30 23 30·79	78 6 2·00	*45·9*			
Rājpur .	30 23 56·83	78 6 0	47·7	*32·3*	57·6	34·1
VIII	30 24 37·72	78 5 35·94	*53·2*	*31·3*	61·7	30·5
IX (Jharipāni)	30 25 10·05	78 5 21·53	*52·5*	*33·6*	62·3	32·6
Mussoorie .	30 27 40·38	78 4 17·66	36·5	28·2	46·1	37·7
Nāg Tiba .	30 35 11·57	78 9 9·90	*30·5*	23·5	38·5	37·6
					Mean	34·0

The direction of the resultant deflection does not vary very much and its mean value is 34°·0 East of North. The latitude stations Dehra Dun, III, IV, V, VI show deflections which could have been derived by simple interpolation between Dehra Dun and VI. A convenient way of exhibiting this is to plot the stations and to draw a line making 34° with North and to draw perpendiculars from the several latitude stations so as to find the component of distance apart along this line, which we have just found to coincide with the mean direction of the deflections.

As the latitude stations between Dehra and Rajpur showed only small irregularities it was not thought necessary to observe azimuths at the intermediate stations.

As regards the latitude stations VIII and IX it is at once apparent that the values obtained by observation are much greater than would have been deduced by interpolation between the Rajpur and Mussoorie values; the actual amounts of excess being 7″·5 and 9″ respectively. This is in agreement with what had been anticipated. We have perhaps not even yet found the place of maximum deflection, but the deflection 62″·3 at Jharipani is the greatest ever observed at any place in the world.

The excess of actual over previously estimated values of deflection in the meridian may be taken provisionally as on an average 4″ between Rajpur and Mussoorie, and it reduces the above-mentioned discrepancy in the height of Mussoorie from 1·94 to 1·58 feet. The effect of the observed azimuths is in the opposite direction but is of much smaller amount. In this case the excess of the observed over the interpolated values of the deflection is only 1″ and the effect of this is to increase the 1·58 feet found above to 1·61 feet.

The net result of the enquiry is accordingly to reduce the original discrepancy of over 3 feet to one of 1·6 feet. This residual is presumably of the nature of an error and is to be accounted for by uncertainties of refraction and instrumental error of graduation which have affected the vertical angles; and by errors in the length of the levelling staves, and changes of length therein with temperature and humidity, which have produced an error in the observed difference of height. To account entirely for the discrepancy of 1·6 feet an error of 6″·6 in the vertical angle, or one of 1/2920 (*i.e.*, 1 mm. in 10 feet) in the levelling staves, must be postulated.

As regards the latitude of Nag Tiba it is of interest to note that the observed value differs only by 0″·8 from a value computed from the actual vertical angles observed there and at Mussoorie to the snow-peaks, after correction, as fully as is possible at present, for refraction. The agreement in the directions of deflection at Mussoorie and Nag Tiba, namely, 37°·7 and 37°·6, is also noteworthy.

Longitudes by Wireless Telegraphy.

In August 1913, Commander Alessio and Professor Abetti of the de Filippi Expedition visited Dehra. It was then arranged to reciprocate with the Expedition in the determination of longitudes by means of wireless telegraphy. The arrangement decided on was that the Radio Office, Lahore, should send out time signals accordingly to a definite programme on such dates as might be found necessary, and that these

signals should be received by the Expedition and Dehra Dun simultaneously, the local time of the signals being determined with as much accuracy as possible. Practice observations were begun when the members of the Expedition were in winter quarters at Skardu. The first set of observations were only partially successful owing to the novelty of the work, and unfavourable weather. Later on with further practice and better equipment the signals were in most cases duly received. The form of aerial used at Dehra Dun was of the umbrella type with six wires emanating from a mast 98 feet high and spreading out radially between 300 and 500 feet. This was found to give stronger signals than the horizontal aerial originally tried. Both aerials set up in the compound of the Trigonometrical Survey Office in which there are many large trees, and these were possibly unfavourable to the horizontal aerial which was only some 8 feet above the ground.

Up to July 1914 the longitudes of five stations, Skardu, Kargil, Lamayuru, Leh, Depsang Plains, have been observed and one more, Shahidulla, is to be attempted in August. The latter will be an interesting station as it is situated north of the main Karakoram Range.

In addition to the longitude work, the wireless signals have been observed for some months twice a week and simultaneously the local time has been determined. This has been done with the object of assisting the Expedition with the rating of its clocks and chronometers for purposes of pendulum and magnetic observations. It is hoped that in this way observations which have been spoiled by failure of the Expedition to observe time, owing to bad weather, may become available.

It was anticipated that " atmospherics " would be very troublesome from May onwards. This has not proved to be generally true and in a good many cases wireless time signals have been recorded and time observations made in spite of the uncertain weather of the monsoon months.

BOTANY.

I.—BOTANICAL SURVEY.

BY

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Eastern India.—During his stay at Kew the Director was partly employed in advancing towards completion the second (systematic) volume of the Catalogue of flowering plants cultivated in the open in the Royal Botanic Garden, Calcutta. During the year an alphabetical list of those cultivated plants compiled by the Director was issued to serve as a provisional index to the systematic volume and as a medium of exchange with other botanical gardens and institutions.

From Assam a welcome accession to the collections of the Survey was a general collection of plants made by Rai Bahadur U. N. Kanjilal, who is engaged in the preparation of descriptive lists of the forest trees and shrubs of that province. Over 800 sheets were contributed as the results of a tour in the Garo Hills made by Messrs. D. Hooper and S. C. Banerji of the Botanical Survey. The mosses collected by Mr. I. H. Burkill, formerly of the Botanical Survey, in the Abor country during the expedition of 1911-12 were worked out by Mr. H. N. Dixon and the results published in the Records of the Botanical Survey. Five new species and one new variety are described. Although the collection is comparatively small, amounting to a little over 60 numbers, it contains representatives of the three floral regions of Siam, Burma and the Himalaya. The occurrence of species of the genus *Symphyodon* inclines Mr. Dixon to view the Khasia district as a centre of dispersal of this genus at least. Active exploration work in Burma has suffered by the retirement or transference of such officers as Mr. J. H. Lace, lately Chief Conservator of Forests in that province, and Captain S. M. Toppin, R.G.A. Mr. Lace, however, has continued his work on the Flora of the Maymyo plateau and has contributed about 400 specimens from that region. Several new species were found amongst the number. Various botanists have published papers on the botany of Burma during the year. Messrs. W. W. Smith, S. C. Banerji and M. S. Ramaswami have described in the Botanical Survey Records eighteen new Burmese species, while Messrs. Craib and Gamble have published a considerable number of new Burmese species in the Kew Bulletin.

Mr. Gamble has continued his work on the Flora of the Malayan Peninsula and has more especially worked out the families *Proteaceæ* and *Loranthaceæ*, while M. C. de Candolle has contributed an account of the *Piperaceæ* and Professor J. M. Macfarlane an account of the *Nepenthaceæ*. The Director while on leave devoted part of his time to the *Euphorbiaceæ* of that region.

In the Eastern Himalaya collections were made as usual by Mr. G. H. Cave, of the Lloyd Botanic Garden, and also by Mr. C. C. Calder while officiating as Director, and by Dr. H. G. Carter, the Economic Botanist of the Department.

Southern India.—In continuation of the work of late years undertaken in view of the preparation of a Flora of the Madras Presidency—which Flora is now under way—the Botanical Survey gave as much attention as possible to the vegetation of Southern India. Mr. C. C. Calder, the officiating Director, and Mr. Ramaswami explored during August and September 1913 Tranvancore north and west of the Achinkoil river. Despite unfavourable climatic conditions over 2,500 specimens were collected, which are now in process of being worked up. A full report will probably be published in the future. Mr. Ramaswami has completed and published in the Records an account of his tour in Tinnevelly, reference to which was made in last report. The same officer also presented a collection of over 500 specimens of Madras plants that he had collected previous to his joining the Department. This contribution has helped to fill not a few gaps in the South Indian collections.

From the Anaimalai hills Mr. C. E. C. Fischer contributed about 200 sheets, which have been studied and found to contain many of Beddome's species that were not mentioned in the Flora of British India. The Rev. A. Saulière, *S.J.*, has continued to send collections from Madura, while he has published a list of Phanerogams and a separate list of Cryptogams found on the Pulney hills. The mosses that had been collected by Mr. C. E. C. Fischer and others in Southern India and Ceylon were worked out by Mr. H. N. Dixon, and the results have appeared in the Records. The species described are fifty-eight and include six new ones. In connection with the preparation of a Flora of Madras, large consignments of specimens have been lent to Mr. Gamble.

Western India.—Within the boundaries of India itself there is little to be recorded. Mr. L. T. Sedgwick has continued his moss studies and has published in the *Journal of the Bombay Natural History Society* a third list of Western India mosses. Although Aden is geographically not part of India, reference is here called for Father Blatter's Flora of Aden, the first part of which has been published in the Record, while the remaining parts are in course of publication.

Central India.—Mr. R. J. D. Graham has studied the grass and sedge Flora of the Nagpur and Telnikheri farms and published descrip-

tions of about 200 species. The same officer has also published a list of the plants of Ramtek in the Central Provinces, in which about 200 species are enumerated.

Northern India.—A further instalment of Mr. Duthie's Flora of the Upper Gangetic Plain is now in the press comprising descriptions of the genera and species of the families *Nyctaginaceæ* to *Ceratophyllaceæ*.

Mr. Gill of the Kumaon Government Gardens collected about 400 sheets of Kumaon plants, amongst which were found several new records for that area. The collection also included several European and American introduced species. Lady Bourne presented a small collection of Delhi and Simla plants, amongst the latter being several species not mentioned in Collett's "Flora Simlensis." From Kashmir over 200 specimens were presented by Captain F. E. Koebel, while a small but highly interesting collection of about 60 sheets made by Lieutenant K. Mason, R.E., of the Survey of India, on the Taghdumbash Pamir at an elevation of 13,000 to 16,000 feet contained several new species and several new distribution records.

General Systematic.—While on leave the Director was employed in preparing a monograph of the Indian species of *Euphorbia*, which will be published in due course. M. Benoist has continued his studies of the *Acanthaceæ* of Asia. M. Guillaumin has published an account of the Asiatic species of *Sonerila*. Count Martelli has published an enumeration of *Pandanaceæ*. The classification of *Coniferæ* forms the subject of a paper by W. T. Saxton. In the Planzenreich, Krause contributes an account of *Philodendreæ* of the family *Araceæ*.

A list of papers containing references to the Botany of India published mostly during 1913-14.

ARBER, AGNES . . On the structure of the Androecium in *Parnassia* and its bearing on the affinities of the genus. (*Ann. Bot., xxvii, No. cvii, 1913, p. 491-510, with 1 plate.*)

BAMBER, C. J. . . Plants of the Punjab. (*Journ. Bomb. Nat. Hist. Soc., xxii, No. 3, p. 569.*)

BANCROFT, N. . . On some Indian Jurassic Gymnosperms. (*Trans. Linn. Soc., viii, Part 2, 2nd Ser., p. 69-103, with 3 plates.*)

Pteridosperm Anatomy and its relation to that of the Cycade. (*New Phytologist, xiii, Nos. 1 & 2, p. 41-68.*)

BAUMGARTNER, P. . Untersuchungen an Bananenblutenstanden. (*Bot. Centralbl., xxx, Helt 3, 1913, p. 237-368.*)

BEAUVERD, G. . . Contribution à l'étude des Composées. (*Bull. Soc. Bot., Genève, 2nd Series, iv, Nos. 1 & 2, p. 13-40.*)

BECCARI, O. . . The Species of *Calamus*. (*Annals Roy. Bot. Gard., Calc., Appendix, 1913, p. 1-142, with 83 plates.*)

BENOIST, M. R. . Contribution à la flore des Acanthacées asiatiques. (*Bull. Soc. Bot., France, xiii, 1913, p. 266-273.*)

BLATTER, E. S. J. . Flora of Aden. (*Rec. Bot. Surv. Ind., vii, No. 1, 1913, p. 1-79, with a map, 4 charts and 5 photographs.*)

,, ,, . The Palms of British India and Ceylon, Part IX. (*Journ. Bomb. Nat. Hist. Soc., xxii, No. 3, p. 444-463.*)

BOSE, J. C. . . On Diurnal variation of Moto-excitability in *Mimosa*. (*Annals of Botany, xxvii, p. 759-779.*)

BRAND, A. . . Zwei neue Borraginaceen-Gattungen. (*Repert. Spec. nov. reg. veget., xiii, Nos. 6 to 8, p. 81-83.*)

CHIBBER, H. M. . On variations in the flowers of *Limnanthemum indicum* Thw. (*Journ. Proc. Asiat. Soc. Beng., ix, No. 5, p. 191-193.*)

,, ,, . . The Morphology and Histology of *Piper Betle* Linn. (*Journ. Linn. Soc., xli, p. 357-383.*)

CHRYSLER, M. A. . The origin of the erect cells in the Phloem of the Abietineæ. (*Bot. Gar., lvi, 1913, p. 36-50.*)

COMPTON, R. H. . An investigation of the seedling structure in the Leguminosæ. (*Journ. Linn. Soc., xli, p. 1-122.*)

COPELAND, E. B. . Daily growth movements of *Lagerstroemia*. (*Philipp. Journ. Sc., viii, p. 287-298.*)

CRAIB, W. G. . . Descriptions of new species. (*Kew. Bull. No. 3, 1913, p. 113-117, and No. 1, 1914, p. 28-29.*)

,, ,, . . Notes on Himalayan Primulas. (*Journ. Roy Hort. Soc., xxxix, Part 1, p. 185.*)

,, ,, . . Plantae Meeboldianae Novæ. (*Repert. spec. nov. reg. reget., xii, Nos. 25 to 27, p. 391.*)

CRAIB, W. G. . . Contributions to the Flora of Siam. (*Additamenta, iv & v, Kew Bull. No. 6, 1913, p. 199, & No. 1, 1914, p. 4.*)

CRAIB, W. G. & SMITH, W. W. A new *Pleurospermum*. (*Trans. Proc. Bot. Soc., Edin., xxvi, p. 154.*)

DIELS, L. . . . Diapensiaceen-Studien. (*Bot. Jahrb., l, Suppl., p. 304-330.*)

DIXON, H. N. . . (1) Report on the Mosses of the Abor Expedition, 1911-12. (2) Report on the Mosses collected by Mr. C. E. C. Fischer and others from South India and Ceylon. (*Rec. Bot. Surv., Ind., vi, No. 3, p. 57-89.*)

DUNN, S. T. . . A revision of the genus *Millettia* W. & A. (*Journ. Linn. Soc., xli, p. 123-243.*)

,, ,, . . Diagnoses of new species in Decades Kewenses. (*Kew Bull. No. 1, 1914, p. 26-30.*)

ERNST, A., & SCHMID, ED. Uber Blute und Frucht von *Rafflesia*. (*Ann. Jard. Bot. Bviten, 2nd Ser., Vol. xii, p. 1.*)

GAGE, A. T. . . Alphabetical List of Non-herbaceous phanerogams in cultivation in the open in the Royal Botanic Garden, Calcutta. (*Bengal Secretariat Press, 1913.*)

GAMBLE, J. S. . . Diagnoses of new species in Decades Kewenses. (*Kew Bull. Nos. 3 & 5, 1913, p. 116, 187.*)

GRAHAM, R. J. D. . List of grasses and sedges found on the Nagpur and Telinkheri farms, etc. (*Nagpur Govt. Press, 1913.*)

,, ,, . Notes on a collecting tour at Ramtek. (*Journ. Bom. Nat. Hist. Soc., xxii, No. 2, p. 237-242.*)

GROOM, P. . . The structure of the wood of East Indian species of Pinus. (*Journ. Linn. Soc., xli, No. 283, p. 457.*)

GUILLAMIN, A. . . Contribution à l'étude des Melastomacees d'Extreme-Orient. (*Bull. Soc. Bot., France, xiii, p. 273.*)

HAINES, H. H. . . A new species of *Euonymus*. (*Ind. Forest., xl, No. 3, p. 94.*)

,, ,, . . *Hibiscus pachmarhicus* Haines. (*Kew Bull. No. 1, 1914, p. 24.*)

HAMET, R. . . *Sedum Henrici*. (*Repert. spec. nov. reg. veget., xii, Nos. 25 to 27, p. 407.*)

HAMET, R. . . Uber vier neue Sedum aus Sikkim und Peru. (*Bot. Jahrbüch, l, Heft 4, p. 8.*)

HOLMES, E. M. . The varieties of the saffron *Crocus*. (*Pharm. Journ., xci, p. 941.*)

HUTCHINSON, A. H. . The male Gametophyte of *Abies*. (*Bot. Gaz., lvii, No. 2, p. 148.*)

IRMSCHER, E. . . Die Verteilung der Geschlechter in den Inflorescenzen der Begoniaceen. (*Bot. Jahrb., l, Suppl., p. 556.*)

KELLEY, W. P. . . The function of manganese in plants. (*Bot. Gaz., lvii, No. 3, p. 213.*)

KOEHNE, E. . . Die Gattung *Pygeum* Gaertn. (*Bot. Jahrbüch, li, Heft 2, p. 177.*)

KOIDZUMI, G. . . Conspectus Rosacearum Japonicarum. (*Journ. Coll. Sc., Tokyo, xxxix, p. 1.*)

KNUTH, R. . . Ein Beitrag zur Systematik und geographischen Verbreitung der Oxalidaceen. (*Bot. Jahrb., l, Suppl., p. 215.*)

LEAKE, H. M. . . Note on the "fruiting male" of *Phoenix dactylifera* L. (*New Phyt., xiii, Nos. 1 and 2, p. 69.*)

LEVEILLE, H. . . Decades plantarum novarum CXIX—CXXIV. (*Repert. spec. nov. reg. veget., xii, Nos. 17-21, p. 281.*)

MAIDEN, J. H. . . A critical revision of the genus *Eucalyptus*. (*Vol. ii, Parts 8—10, and Vol. iii, Part 1.*)

MARTELLI, U. . . Enumerazione delle "Pandanaceæ." (*Firenze, 1913.*)

MEMMLER, H. . . Die Gattung Nymphaea. (*Gartenflora, Heft 4, p. 84-91.*)

MERRILL, E. D. . Studies on Philippine Melastomaceae, I. (*Philipp. Journ. Sc., viii, Sec. C, No. 4, p. 207.*)

NIEDENZU, F. . . Uber die Fortentwicklung in der Familie der Malpighiaceæ. (*Bot. Jahrb., l, Suppl., p. 162.*)

OSAWA, I. . . On the Development of the Pollen-grain and Embryo sac of *Daphne*, with special reference to the sterility of *Daphne odora*. (*Journ. Coll. Agri. Imp. Univ., Tokyo, iv, No. 5, p. 237-259.*)

PETCH, T. . . .	An orchid new to Ceylon. (*Annals Roy. Bot. Gard., Peradeniya, v, Part 4, p. 387.*)
RAMASWAMI, M. S., & BANERJI, S. C.	General Index to Vol. IV. (*Rec. Bot. Surv. Ind., iv, No. 8.*)
SAXTON, W. T. . .	The classification of Conifers. (*New Phyt., xii, No. 7, p. 242.*)
SCHENCK, H. . .	Die myrmekophilen Acacia-Arten. (*Bot. Jahrb., l, Suppl., p. 449.*)
SEDGWICK, L. J. .	A third list of Mosses from Western India. (*Journ. Bomb. Nat. Hist. Soc., xxii, No. 2, p. 370.*)
SMITH, W. W. . .	A new and peculiar *Astragalus* from the Tibetan Frontier.
,, ,, . .	*Hibiscus Watsoni.* (Hook. Ic. Pl. Tab., 2990.)
,, ,, . .	Two new Himalayan species from the Chumbi Valley. (*Trans. & Proc. Bot. Soc., Edinb., xxvi, Part II, p. 118.*)
SMITH, W. W., & CAVE, G. H.	A note on the Himalayan species of *Daphne*. (*Rec. Bot. Surv. Ind., vi, No. 2, p. 45.*)
,, ,, . .	(1) Note on the East Himalayan species of *Alangium*.
SMITH, W. W. . .	(2) Species Novae Plantarum in Herbario Horti Reg. Calcutt. Cognitarum. (*Rec. Bot. Surv. Ind., vi, No. 4, p. 93.*)
SMITH, W. W., & BANERJI, S. C., & RAMASWAMI, M. S.	New Indian Didymocarpi. (*Rec. Bot. Surv. Ind., vi, No. 2, p. 41.*)
SMITH, W. W., & BANERJI, S. C., & RAMASWAMI, M. S.	Two decades of new Indo-Burmese species. (*Rec. Bot. Surv. Ind., vi, 2, p. 29.*)
SPRECHER, A. . .	Recherches sur la variabilite des sexes dans *Cannabis sativa* L. et *Rumex acetosa* L. (*Ann. Sc. Nat., 9me Serie, xvii, Nos. 5 and 6, p. 255.*)
STAPF, O. . . .	Diagnoses of new species in "Decades Kewenses." (*Kew. Bull. No. 9, 19 , p. 354.*)

BOTANY.

II.—ECONOMIC BOTANY.

Part I.—Agricultural Botany.

BY

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The present report deals with the results obtained in Economic Botany in India during the year ending June 30th, 1914. The programmes of work in progress on this subject have already been published and are to be found in full in the *Proceedings of the Board of Agriculture in India* for 1913. One paper, relating to the flowering of rice in Japan, has also been referred to in the report as it deals, in great detail, with similar work now being taken up in India. A list of papers published during the year is appended.

Cotton.—Beyond one paper by Mr. Leake there is nothing of a purely botanical nature to record in the case of this important crop. This investigator is at present engaged in the study of the factors concerned in the ginning percentage of Indian cottons. The preliminary results are published in the current number of the *Journal of Genetics*. The ginning percentage, or the number of pounds of lint obtained from 100 lbs. of seed-cotton, is a most important character from the cultivator's point of view. The price paid to the grower for the seed-cotton (*kapas*) is roughly proportional to the ginning percentage. In the United Provinces, the average weight of lint obtained from 100 lbs. of seed-cotton varies from 30 to 33 lbs., while selected varieties have been isolated which yield as much as 41 lbs. of lint. The worst cottons cultivated, however, may fall as low as 15. It is clear that the ginning percentage is a most important matter and one which may easily repay detailed investigation. That it is a composite character is proved by the fact that among the progeny of numerous crosses made at Cawnpore between two parent types, each having a ginning percentage of 25 to 26, forms have been isolated for which the figures diverge as much as 36 and 18. These facts also indicate the economic possibilities which lie before the cotton breeder working on scientific lines. The author shows that ginning percentage, the number of fibres per seed, the weight of 1,000 fibres and the volume of the cotton-seed form a closely

interrelated group in which variation in any one character is very fully accounted for by variation in one or other of the other three. Of the three characters by which the ginning percentage may be affected, one only, namely, the number of fibres per seed, has any marked effect on the value of the ginning percentage.

Although the output of results on cotton from the centres of Agricultural Research in India continues to be relatively small in amount, nevertheless this crop is receiving a great deal of attention from the Deputy Directors of Agriculture in several Provinces. A large amount of seed distribution is in progress and in practically every case the improvement has been made by the Deputy Directors themselves either by simple selection from the country crop or by the introduction of a suitable American cotton. Such seed distribution schemes are now in progress in the Central Provinces, Madras, Bombay, United Provinces, Punjab and Sind, and a comparison of these various efforts and of the results obtained leads to several interesting conclusions. The various schemes fall into two classes. In one, *the improvement of the quality of the lint* is the main object and into this class falls most of the work in Madras, in Bombay, Sind and in the Central Circle of the United Provinces. In the remaining schemes, the chief object is the *increase in yield* and no question of quality arises as the cottons in all these cases are characterised by a short staple. The most important projects in this class of work are those in the Eastern Circle of the Central Provinces and in the Western Circle of the United Provinces.

The difficulties which have to be overcome in establishing a cotton with an improved staple under Indian conditions are well known. The variety has first to be fixed so that it breeds true from seed. It is also most desirable that the new kind should stand out from and be easily distinguished in the field from the local cottons. A large amount of pure seed of the new variety, which must be hardy enough to suit the growers and also give a satisfactory yield, must be available for the work of seed distribution. In order to prevent degeneration through crossing, anything short of complete replacement by the new kind from definite centres, preferably from places where markets exist, cannot be regarded as satisfactory. The ginning of the improved cotton must be done locally to prevent admixture of seed at the large ginneries. To enable the growers to obtain the real value of the product, official assistance in marketing the early consignments is desirable and both the growers and dealers must realise that anything in the shape of adulteration will, in the long run, be harmful to their best interests. It is clear that the production of an improved cotton suitable to any tract in India is only the first step in the work. The greatest difficulties to be overcome are those which arise in the organisation of seed

distribution, in the supply of pure seed, in the prevention of adulteration both in seed and in lint and in the building up of that confidence on the part of buyers and spinners which is essential if India is ever to establish her reputation as a producer of really high class cotton. In the current reports of the various Provinces there are constant references to the difficulties before the Agricultural Department in these matters. The mixing of seed at ginneries, the wilful adulteration both of seed and of lint, the deterioration of the product as the result of natural crossing and admixture of seed and the difficulties in the organisation of the seed supply are frequently mentioned.

One method of dealing with the difficulties in establishing an improved cotton is to concentrate the seed distribution in a comparatively small area, such as a portion of a single District, and to establish there first of all a large Government seed farm with its own ginnery. This seed farm would serve both as a demonstration of the superiority of the improved cotton and also as a source of seed. If suitable Agricultural Unions, such as those of the Central Provinces, can be formed round the central farm and if the members undertake to grow the improved cotton only and to gin it themselves, there seems no reason why, in the course of a few years, the cotton crop in the area in question could not be replaced entirely by the new form. Once the new kind is thus completely established and the area has built up a reputation as a producer of an improved cotton, the operations of the Agricultural Department could be transferred to other tracts and the process repeated. It is exceedingly probable that concentration of effort on a comparatively small area is the only means of success in undertakings such as this under present Indian conditions.

Many of the difficulties inherent in the improvement of the quality of Indian cotton are not encountered to the same degree if attention is restricted to the improvement of the yield only. Among the Indian schemes which are concerned only with the improvement of the yield, that developed by Mr. Clouston in the Eastern Circle of the Central Provinces is the most important. The history of this scheme is of considerable interest. Relying on the advice of Lancashire to grow long stapled cottons, efforts were continually made in the past in the Central Provinces to persuade the cultivators to grow *bani*, a long stapled local variety which, however, gives a low yield of fibre. In spite of this advice, however, the cultivation of the short stapled *jari* mixture gradually extended. Eight years ago the efforts of the Agricultural Department were still concerned with the spread of *bani*. At this point Mr. Clouston took up the matter. The cottons of the Province were first classified and varietal trials were carried out at the Akola farm. The results for the last seven years are summarised in the statement annexed on next page.

Variety.	Average outturn of lint (seers per acre).
Roseum	101·8
Roseum cutchica	97·5
Berar Jari	85·5
Malvensis	68
Verum	73·6
Upland Georgian	32·5 (average for two years).
Buri	59·4
Bani	51·4

Thus Roseum, one of the six constituents of the local *jari* mixture, proved to be the highest yielder and although a short stapled cotton, is the most profitable to grow. In the above experiment, the average value of Roseum per acre at present prices is about ten rupees above *jari* and thirty-one rupees above *bani*. This result brings out in a striking way the fact that quality by itself does not make up for a low yield. Although the staple of Roseum is short, the ginning percentage is as high as 40 while the plant is robust, prolific and well suited to the general agricultural conditions of the cotton growing tracts of the Central Provinces. The method of seed distribution of this variety is based on the Akola farm which yearly grows a large quantity of Roseum for seed. The overcoming of the difficulties connected with the supply of pure seed to the growers and with admixture at ginneries is being attempted by means of Agricultural Unions, the members of which grow only Roseum cotton. The members obtain their seed from the Union central farm which is supplied from a Government farm where Roseum is grown pure. The unions are advised to provide small ginning plants driven by an oil engine and for this Government is willing to advance a loan of two thousand rupees. This cotton has already covered an enormous area and it is estimated that there is this year sufficient seed for nearly 200,000 acres. The spread of Roseum in the Central Provinces emphasises the importance of yield and general agricultural fitness in any cotton variety brought to the notice of growers. It also brings out the point that the growers themselves had not recognised the superior value of one of the constituents of one of their commonest cottons and it was not till the local sorts were grown

side by side at a Government farm that the superiority of Roseum was demonstrated. This failure of the cultivators to recognise the most profitable cotton in the Province is, however, to be expected in a country like India where the standard of agriculture is so low. Two other aspects of this scheme also deserve attention. It is an admirable instance of the success which attends concentration of effort on one object at a time. After the superiority of Roseum was recognised, the efforts of the Agricultural Department in this Circle were concentrated on the spread of this variety with the result that in eight years after the matter was first taken up, the work of the Department in the Eastern Circle of the Central Provinces on cotton has been very favourably reported on by Mr. Arno Schmidt, the Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations. Another aspect of the spread of Roseum suggests itself. It seems worth considering whether the Agricultural Department should rest content with spreading a short staple cotton in this area. The existence of such a robust agricultural type of cotton as Roseum and the development of the system of seed distribution by means of Agricultural Unions offer an unique opportunity for the plant breeder. It ought to be possible to add to the good qualities of Roseum the further character of high quality lint. It would almost be a calamity if advantage is not taken of this exceptional opportunity of showing the value of the application of science to practice.

Wheat.—Investigations on the improvement of Indian wheat are now practically confined to the work carried on from Pusa which has been referred to in previous reports.

During the year the experiments on the influence of the environment on the milling and baking qualities of wheat, which are being conducted in collaboration with Mr. Leake, have yielded important results. The object of this work is to determine whether the improved Pusa wheats would lose their grain qualities when transferred from Pusa, where they are grown as a dry crop, to the canal irrigated tracts of Northern India and to the black soil areas of the Peninsula. Twenty-eight samples of wheat, comprising six new Pusa varieties, were grown at fourteen stations (Pusa, Bankipore, Dumraon, Partabgarh, Cawnpore, Aligarh, Meerut, Gurdaspur, Lyallpur, Mirpurkhas, Raipur, Tharsa, Orai and Hoshangabad) and were tested in England by Mr. A. E. Humphries both in the mill and subsequently in the bakehouse. He summarises his report (dated October 3, 1913) as follows:—

"It has again been demonstrated that wheats of the highest class can be grown in India on several kinds of soil and on land which has been irrigated. It has been shown that the high excellence of quality possessed by wheats grown at Pusa in previous seasons was not due to environment or agricultural practice, for the same varieties of wheat have

yielded still better results elsewhere. It is interesting to note that this high excellence of quality was found existing in wheats indigenous to India and that in the Pusa Nursery varieties, the progeny appear to possess, intact, the great strength of the strong parent. I have no doubt that any or all of the wheats tested will realize, some at once, some later, relatively higher prices on our markets than the existing Indian wheats of commerce. If these new varieties yield no more grain and straw per acre than those ordinarily grown, their extended distribution as seed is desirable; if in addition the new varieties will yield greater quantities of grain and straw than those ordinarily grown, the position of the Indian grower will be greatly improved and the propagation of the new kinds should be pressed forward."

The outstanding feature of the work of the last year has been the demonstration of the fact that one of the wheats (No. 12) referred to in Mr. Humphries' report has given exceedingly good results when grown by the cultivators. Judged by the returns obtained by the people themselves, not only in almost every District from Gurdaspur in the Punjab through the United Provinces to Bhagalpur in Bihar but also on the black cotton soils in Bundelkhand and in the Central Provinces, this wheat has invariably given the highest yield. It has also more than retained its high milling and baking qualities over these areas. In addition, it is earlier than the local sorts and comes to maturity with less water than most of the wheats now grown. All these circumstances and the fact that it is likely to prove as suitable for consumption in India as for the export trade, indicate that the time has come when a new and improved grade of Indian wheat can rapidly be established. Pusa 12 is now being distributed to cultivators by the Agricultural Departments of the United Provinces, Bihar, Punjab and Central Provinces. The supply of seed last April was, however, far below the demand and in particular the indents from the United Provinces could only in part be met. In order to supplement the seed supply in the various Provinces, arrangements have been made and are now in working order to grow about 10,000 maunds of seed of the Pusa wheats on seed farms near Pusa under the control of the Imperial Economic Botanist. During the past wheat season upwards of 11,000 maunds of Pusa wheat, true to type, was grown on these farms. During the coming year it is expected that a larger quantity of seed, including 8,000 maunds of Pusa 12, will be available for distribution.

Sugarcane.—In the last report, a detailed account was given of the work in progress and in contemplation at the new sugarcane station at Coimbatore. A still more detailed account of the cane breeding work in Madras and of the other aspects of the improvement of the sugar industry in India is to be found in the *Proceedings of the Board*

of Agriculture in India held at Coimbatore in December 1913. Much of the work now in progress is necessarily of a preliminary character and some years must elapse before any definite progress can be recorded. The choice of Coimbatore as the site for the cane breeding station has been fully vindicated in so far as the production of numerous fertile seeds is concerned and the possibility of raising large numbers of seedlings. It has been found that several North Indian canes, which are infertile in the Gangetic Plain on account of the fact that the anthers do not produce pollen during the dry period when the canes flower, nevertheless produce fertile seed when grown under more humid conditions at Coimbatore. Progress has also been made by Dr. Barber in the classification and description of the indigenous canes of India and a paper on the narrow-leaved Punjab canes is being published. It is proposed to publish descriptions of the indigenous canes of other Provinces and to work out a detailed classification of the canes of India as a whole. In Bihar, a paper on the canes collected at Sabour by Mr. Woodhouse is expected to appear shortly.

An interesting point relating to sugarcane varieties has been investigated by Mr. Somers Taylor at Sabour, which is likely to prove of considerable value in future variety trials. This relates to the effect of the quality or kind of the fibre on the amount of juice retained by the bagasse. It seems probable that the quality of the fibre is a varietal character and one which will prove of great use in valuing canes and deciding between the merits of different varieties.

Perhaps the most important point to record with regard to the work on sugarcane in India during the year is the establishment of a sugarcane station at Shahjahanpur in the United Provinces under the direction of Mr. Clarke, the Agricultural Chemist. This station has been well equipped and is now in working order and a bulletin has been published dealing with the results obtained. This relates to the efficiency of the small iron mills in use in India and the interesting point is brought out that although the extraction is very high, nevertheless it is questionable whether these mills are any advantage to the cultivator. The rate of crushing is low and the amount of bullock power required is very great, often far greater than the cultivator can really afford. If some other source of power like an oil engine could be used at the local crushing centres, a large amount of bullock power could be released for agricultural work and for extending the area under cane which is now limited by the cattle power available for crushing. The establishment of this station under the Agricultural Chemist is significant of the growing tendency on the part of the scientific members of the Agricultural Department to consider the agricultural aspect of their investigations and to combine practice with science. The view that a first hand knowledge of practice

is an essential condition in all investigations relating to Indian Agriculture is gradually gaining ground in the Department and the point of view, that in all this work science is rather the instrument than the end, is making steady progress.

Rice.—The rice crop in India is now beginning to receive attention and an account of a preliminary discussion of the subject appears in the last issue of the *Proceedings of the Board of Agriculture in India.* No very definite suggestions as to the lines on which future work on the crop should be conducted were, however, made.

From the purely botanical aspect the most important paper on this crop which appeared during this year is one by Professor Akemine in the current issue of the *Zeitschrift fur Pflanzenzüchtung.* This investigator has made, at the Agricultural Institute at Sapporo in Japan, a detailed study of the flowering of the rice plant including the details relating to pollination as well as the influence of humidity and temperature on the process of fertilization. This investigation will no doubt prove of considerable interest to all investigators in India who are dealing with this crop.

In India, several papers on rice have been published during the year. In Burma, where the rice crop is of paramount importance, not only from the local standpoint, but also from the point of view of the world's rice trade, the improvement of rice has been taken up by Mr. McKerral, who has published a detailed statement of the problem in the *Agricultural Journal of India* together with an account of the work in progress at Hmawbi. In the Central Provinces, Mr. Graham has published a memoir on the classification of rice. The author concludes that "All rices fall into one of two groups, namely, rices with a green leaf sheath and those with a coloured leaf sheath. The second class may be sub-divided into those with a red leaf sheath and those with a purple leaf sheath. These classes further sub-divide on their vegetative characters, those of the spikelet and those of the grain. In addition to these morphological characters, the time of ripening, though not definite enough to form a main point in the classification of rices from a large area, is of considerable local importance."

Among the reports dealing with the agricultural aspect of rice improvement that of Mr. Clouston on the work in progress in the Chattisgarh Division of the Central Povinces is the most interesting. In this backward tract, the ryots have been shown the advantages of transplanting rice which lead to an average crop increase of one-third, valued at about thirteen rupees per acre. The area under transplantation has risen to 16,000 acres so that the annual increase from transplanting on this area is $16{,}000 \times 13 =$ Rs. 2,08,000 in addition to the saving of seed which amounts to 880,000 lbs. of paddy. In the present phase of development of the Agricultural Department, the most interesting aspect of the

rice work in Chattisgarh is not the amount of extra money gained by the ryots, but rather the organisation used in this demonstration work. Mr. Clouston explains this aspect of the work as follows:—

"With the limited number of Agricultural Assistants at our disposal it would have been impossible to have done instructional work in several hundreds of villages each year, had not another device suggested itself, namely, to employ as instructors a superior type of intelligent and literate ploughmen recruited in districts where agriculture is more advanced. These instructors are designated *Kamdars*. This scheme for the employment of *Kamdars*, who should serve the purpose of instructors in new methods of farming, has been tried in Chattisgarh for the last five years and has proved to be a very sound and practical one. These men at first serve for a time on the Raipur Experimental Farm where they get into touch with our methods. This is necessary, as the work for which they are mostly required is the transplantation of rice and the cultivation of cane, and though they may have had experience in both, still they have much to learn. They have for instance to learn to transplant single seedlings instead of bunches since seedlings are transplanted in bunches, wherever transplanting is practised in these Provinces.

"The advantages to be gained by employing these skilled *Kamdars* for demonstration work are:—(*i*) that being men of cultivating castes they are more in touch with the ryot, (*ii*) that they work with their own hands and are therefore more effective as instructors than our assistants who, being in most cases of a non-cultivating class, are physically less adapted to the practical side of this work, and (*iii*) that nearly all our *Kamdars* have been recruited from villages in the rice tract, and therefore stand the climate much better than do our trained assistants of the higher caste recruited from the towns."

It is probable that we have here the solution of the problem of the best means of manning the Agricultural Department of India in the future. Instead of recruiting students from Agricultural Colleges, it is exceedingly probable that a more efficient staff could be obtained from the cultivating classes trained as boys on the Government farms.

Indigo.—Recently the investigations on indigo in India have undergone considerable modification. The Sirsiah Experiment Station, which had been conducted for many years by the Bihar Planters' Association with the help of an annual subsidy from Government, was closed on March 31st, 1913, the staff dispersed and the work handed over to the Botanical Section of the Pusa Institute. The reasons which led to this decision are dealt with in detail in the last Sirsiah report, issued in 1913. Briefly stated, it was found that Java indigo could not be induced to form seed at Sirsiah and, in consequence, the selection work on this crop, which formed the main item of the programme of investigation, was

interfered with to such an extent that no hopes of any successful results could any longer be entertained. The causes of the non-success of the Sirsiah experiments with Java indigo have been put down to a diseased condition of the plant, known locally as "wilt," which has been the means of reducing the area under this variety in Bihar from 70,000 bighas in 1910 to 15,000 bighas in 1913. This has naturally been a great blow to the indigo industry in Bihar as great hopes were built on the Java plant, when this variety, soon after its introduction in Bihar in 1898, gave much higher yields of indigo than the Sumatrana variety. Everything went well till 1909 when the dry cycle, during which this crop was introduced into Bihar, came to an end and a series of rainy years commenced. The vigour of Java indigo fell off and the weak plants produced a poor crop of seed. This poor seed in turn gave rise to still weaker plants and the cultivation of Java indigo in Bihar soon found itself in a thoroughly vicious circle and in danger of collapse on account of the difficulty of getting sufficient seed.

The diseased condition of Java indigo has been very thoroughly investigated by three of the sections of the Pusa Institute as well as by the staff at Sirsiah. In all cases the results were negative and no cause could be found to account for the wilting of the indigo which began after the first cut, increased during the monsoon and led to the gradual death of the plants during the succeeding cold weather. The subject of the diseased condition was then taken up by the Botanical Section at Pusa. It was found that the wilt of Java indigo closely resembles the similar condition common in such plants as *sanai* (*Crotalaria juncea*, L.) and *patwa* (*Hibiscus cannabinus*, L.) when these crops are sown for seed at the beginning of the monsoon in rainy years. In all cases these deep rooted plants cannot tolerate indefinitely a long continued, constantly wet condition of the soil. Under such conditions the feeding roots are destroyed and little of the root system besides the main roots remains. With the progress of the root trouble, leaf fall sets in followed by a diseased wilted condition of the whole plant and the crop begins to die off in October and November. The indigo wilt can be regarded as a starvation effect due to the gradual destruction of the active root system.

It was found that if Java indigo is sown for seed early in August on well drained land in good condition that the diseased condition is avoided and good crops of well developed seed are produced the following February. Sown in this way the developing root system follows the fall of the sub-soil water and the roots are not in the wet soil long enough for the diseased condition to establish itself. After giving a crop of seed in March, the indigo plants can be again cut for leaf the following monsoon. These results have been repeated under estate conditions and thus the supply of seed of this crop has been ensured and one of the chief causes of the decline in the area under Java indigo has been removed.

Besides the seed supply other aspects of the improvement of indigo have been investigated. It was found that if the indigo plants are not cut down completely at the first cutting, and if a branch is left to carry on the transpiration current, the amount of wilt is lessened and the weight of the second crop increased. In the Pusa experiments, leaving a branch at the first cut led to a total increase of the crop of about thirty per cent. Cross fertilization by bees is the rule in this crop and consequently the amount of natural crossing is very great. The various forms, however, differ greatly in vigour and it might easily be possible by suitable methods of mass selection to isolate and fix strains of higher yielding power than the present mixed crop. Improvements in the growing of Java indigo have already been discovered at Pusa and these have been taken up on the estates. It was found that the cost of production could be lessened and the yield increased by suitable methods of surface cultivation in the hot weather instead of the costly and inefficient methods of handweeding in vogue in Bihar. The general experience with this crop at Pusa indicates that a considerable amount of improvement can easily be made in the production of indigo and the future of this industry is by no means so hopeless as is often believed.

Tobacco.—The only paper of importance published during the year on this crop is that of Mrs. Howard on the inheritance of characters in *Nicotiana tabacum*, L. This work, which was only possible after the types of Indian tobacco had been classified, described and grown in pure culture at Pusa, was undertaken with a view of discovering the method in which the various characters of economic importance in the tobacco plant are inherited, so that the building up of new and improved tobaccos could be carried out on a scientific basis. For this purpose it was necessary to determine the mode of inheritance of various quantitative characters, particularly those concerned with the leaves and their arrangement on the stem. Parthenogenesis was not found to occur in tobacco at Pusa although every stimulus to apogamous seed formation had been given to the plants by pruning and capsule removal. In raising the experimental cultures sufficiently evenly for the determination of the inheritance of size characters, considerable difficulty was experienced and a good many precautions had to be taken. These are fully dealt with in the paper. The characters investigated include time of flowering, height, number of leaves, arrangement of leaves, venation and leaf shape, all economically important characters. The general conclusions are summed up by the author as follows:—

"The data obtained by a study of the characters of *Nicotiana tabacum* show that there is no inherent difference in the mode of inheritance of ordinary qualitative characters (such as the colour of the corolla) and of those characters connected with the size of the organs which are subject to fluctuating variability. All the results obtained can be explained by the Mendelian assumption of segregation of characters, combined with the

hypothesis that in connection with each character a large number of factors exist, each of which can be inherited independently. This conclusion is supported by the great range of variation in the F_2 generation, the formation of extreme forms in this generation far outside the limits of the parents, the differences and the diminution in the range of variation in the F_3 cultures raised from different variates of the F_2 generation and by the isolation in the F_3 and succeeding generations of forms like the parents and also of intermediate forms which bred true. This isolation of new forms can easily be explained by a rearrangement of the factors."

Fruit.—The subject of fruit-culture in India was considered at the last meeting of the Board of Agriculture. The discussion brought out considerable differences of opinion as to the desirability of devoting more attention to this subject. A resolution was eventually passed recommending that, in Provinces where the fruit trade is considered of sufficient importance to justify an extension of the Department's activities in the direction of fruit investigation and where the subject is not being dealt with at present, a preliminary investigation should be made.

Considerable attention is being paid to fruit at the Saharanpur Botanical Gardens by Mr. Hartless and a new area of land has been planted up in fruit trees. The situation of Saharanpur in the submontane region, the existence of a good railway service of broad gauge lines and the extensive fruit gardens round the town are exceedingly favourable for a fruit station where improved methods of cultivation and packing could be demonstrated and where young trees true to type could be propagated. If the Saharanpur gardens were devoted entirely to fruit-culture the objects advocated in the resolution of the Board of Agriculture could be immediately carried out. During the year Mr. Hartless has published a paper discussing some of the factors concerned in the fruiting of the mango.

Continued attention is being paid to fruit by Mr. Burns in the Bombay Presidency where various questions concerned with the mango crop are being studied. Attempts to cross the mango have again resulted in failure. Attention is also being paid to fruit at the Mirpurkhas agricultural station in Sind by Mr. Henderson, who has found that grapes, peaches and oranges do well. Young trees are now being supplied to the zamindars from this station.

At the agricultural farm near Peshawar, Mr. Brown is continuing his work on fruit-growing, the results of which are given in the Annual Farm report and also in the *Agricultural Journal of India*. Before the establishment of the farm it appears that peaches were grown from seed by the zamindars and the introduction of the method of ring budding on seedlings, which has been practised from time immemorial in India and Persia, has been introduced into this tract and budded trees

are now being distributed. The most interesting result obtained at this station is the demonstration of the superior value of certain stocks for oranges. Malta orange produces the largest amount of vegetative growth on the small sour lime while the Sangtara is most vigorous on the sweet lime. The results of the investigations on dates in the Punjab have been summed up by Mr. Milne during the year.

Considerable progress has been made at the new Fruit Experiment Station at Quetta which has been fully described in the last report of the Pusa Research Institute. The principal results published by this station relate to the improvement in the packing and transport of fruit in India. The paper deals with the present methods of packing fruit, the experiments which have been carried out at Pusa and at Quetta and with the various aspects of marketing including refrigeration and cold storage. The improved fruit packages have been introduced to the notice of the trade at Quetta and have been taken up in increasing numbers during the last two years.

Another aspect of the Indian fruit trade remains to be noticed. This is the possibility of Australian competition and the establishment of cold storage depôts at centres like Bombay and Calcutta. A representative of the Australian Government visited India during the year and his report on cold storage works for India is published in the *Indian Trade Journal* of January 15th of this year. Should Australian meat ever be exported to India and kept in cold storage, there is little doubt that such fruits as apples and grapes would follow in large quantities. In this case, serious competition would arise which might have the effect of raising the standard of agriculture in the various fruit tracts of India.

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Part II.—Forest Botany.

BY

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Œcology of sal and forest grasses.—These subjects have been under investigation for some years and experiments are still in progress. A preliminary paper on the *Œcology of sál* is in the press which gives the results of work done up to date. In order to ascertain whether the various forms of grasses come true from seed, seed was sown in prepared beds during the monsoon, but in no instance has the grass sown come up. In the early stages it is not possible to distinguish the different kinds of grass and the beds have to be left unweeded so that if the seeds sown germinated the seedlings were soon killed out by other grasses which

come up in abundance in the beds. A second sowing has been made in pots of clean river sand, but up to date the results do not seem encouraging. None of the seeds have germinated well and many have not germinated at all. After two months' growth the largest were not big enough to transplant.

Local Forest Floras.—A considerable amount of work is being done in many different provinces with a view to the preparation of descriptive lists and forest floras.

Punjab and Hazara.—The writer was on special duty for six months in the cold weather preparing a forest flora. The great majority of the trees and shrubs of this area are confined to the Himalaya and sub-Himalayan tract. The collections made by Mr. Jerram, Deputy Conservator of Forests, in the course of the revision of a working-plan, have been of great assistance in increasing our knowledge of the flora of the sub-Himalayan tract and lower hills of the Rawalpindi District, an area in which systematic collecting appears never to have been done. The following are the more interesting plants collected by Mr. Jerram: Caryopteris grata, Benth. Rubus paniculatus, Sm. Viburnum coriaceum, Bl. Itea nutans, Royle. Cornus oblonga, Wall. Litsaea sebifera, Pers. Clematis Gouriana, Roxb. Myrsine semiserrata, Wall. Daedalacanthus nervosus, T. And. Wendlandia puberula, DC. Leycesteria formosa, Wall.

United Provinces.—Mr. A. E. Osmaston is engaged in preparing a list of trees and shrubs of the Province. A very large number of specimens were received from him during the year and collections are being made in several divisions.

Bengal.—Collections of plants with forms duly filled up giving the information required for descriptive lists have been received from three divisions.

Assam.—Rai Bahadur Upendra Nath Kanjilal is engaged on preparing a forest flora for Assam.

Central Provinces.—Mr. D. O. Witt is collecting and receiving collections made in various parts of the Province. Mr. H. H. Haines has published two more parts of his "List of Trees and Economic Herbs of the Southern Forest Circle."

Madras.—A revised vernacular list of trees and shrubs of the Presidency prepared by Mr. A. W. Lushington, Conservator of Forests, is in the press. Mr. C. E. C. Fischer is engaged in preparing a Forest Flora for Coimbatore, Madura and parts of Malabar and the Nilgiri Districts.

Andamans.—Mr. Parkinson, Extra Assistant Conservator of Forests, has been collecting during the year and is expected shortly to

visit Dehra for the purpose of preparing a descriptive list of the forest trees for the Andamans.

General Identification Work.—Although many of the Forest Officers engaged on the preparation of list and floras do their own identification a considerable number of specimens are sent to Dehra and much of the time of the Forest Botanist is taken up with identification work. During the year, 1,226 plants were identified for forest officers and others against 294 in the previous year.

List of plants cultivated in the Forest College Grounds and Forest Park.—During the year the trees and shrubs growing in the Forest College grounds and Forest Park have been enumerated and identified as far as possible. The enumeration shows 2,321 plants almost all of which have been identified, comprising 318 species. The Forest Botanist is constantly receiving cultivated garden plants for identification and a knowledge of what is grown in Dehra Dun, specimens of which have been placed in the herbarium, will be of much assistance in this work.

Trametes Pini.—The Botanist's Assistant, Mr. G. A. Allington, has been examining specimens of the wood of *Pinus excelsa* collected by Mr. Hole from trees attacked by *Trametes Pini*. The object of the examination was to ascertain how the fungus attacked the tree and more particularly how it spread from trees in the forest. The following are the results of his examination in so far as they have any practical interest:—

(1) Fungus mycelium was found to be present not only in the attacked and rotted heartwood, but also in the sapwood next the cambium which to all appearance was sound.

(2) Wood from trees supposed to be completely sound was found to contain fungal hyphæ in the tracheids or medullary rays. Assuming that the hyphæ are all of *Trametes Pini*, and there is no reason to believe that more than one fungus is present, they show that the presence of the fungus can be ascertained only by microscopic investigation.

(3) Roots both fine and thick, some of which appeared completely free from rot, were found to contain fungus mycelium in the wood; also in the case of natural root grafts fungal hyphæ were found in both grafted roots on either side of the point where their tissues had completely grown together.

This shows that in the case of natural root grafting the fungus can sometimes at least spread from tree to tree through the roots, and this must be taken into account when instituting protective measures.

It is a remarkable fact that the mycelium of the fungus appears to cause little or no rot in the wood except in the heartwood of the stem and larger roots.

List of papers on Forest Botany.

ANON . . . Seeding of Bambusa arundinacea. (*Ind. For., xxxix, 327.*)

" . . . Destruction of Lantana. (*Imp. Inst. Bull. and Ind. For., xxxix, 551.*)

GROOM, P. . . Critical Identification of the Woods of Indian Pines. (*Ind. For., xxxix, 409.*)

HAINES, H. H. . A new species of Euonymus. (*Ind. For., xl, 94.*)

" " . A new Euphorbia. (*Ind. For., xl, 154.*)

" " . List of Trees, Shrubs and Economic Herbs of the Southern Forest Circle of the Central Provinces, Part III. (*Ind. For., xl, 194.*)

" " . List of Trees, Shrubs and Economic Herbs of the Southern Forest Circle of the Central Provinces, Part IV. (*Ind. For., xl, 264.*)

HOLE, R. S. . . New Indian Species of Forest Importance. (*Ind. For., xxxix, 413.*)

" " . Note on the Preparation of Indian Forest Floras and Descriptive Lists. (*Forest Bull. No. 23.*)

HOOPER, D. . . Drug Culture in British India. (*Ind. For., xxxix, 440.*)

HOWARD, A. . . Natural Root Grafting. (*Agri. Journ. Ind., viii, 1913, 185.*)

RAMA RAO . . An extraordinary phenomenon in a Mahogany seedling. (*Ind. For., xxxix, 327.*)

BOTANY.

III.—MYCOLOGY.

BY

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Officiating Imperial Mycologist.

I.—Plant Pathology.

The Agricultural Research Institute, Pusa.—The following diseases were investigated during the year.

Rice diseases.—The inquiry into the *ufra* disease of rice was continued. It has been established that the organism responsible for the damage is a form of eelworm (*T. angustus*) belonging to the genus *Tylenchus*, of which several species are known to cause serious diseases of cereals. Inoculations with material which, so far as could be determined, contained no other constant organism but the worm, have been successful in producing typical *ufra* in localities where the disease is quite unknown. The disease commences its ravages in July and culminates about September-October when large numbers of motile worm are present. After December they remain immotile and dormant in the dry grains and probably re-commence activity only with the flooding of the fields after sowing; experiments have shown that *T. angustus* can withstand desiccation for even 15 months. It is a curious fact that transplanted paddy appears to be comparatively immune to natural attack. During the present year efforts have been made to map out the extent of the infected area and an experiment is in progress at Comilla to test remedial measures. It is probable that burning the stubble on the soil after winter harvest will be found to be the most efficient means of combating this disease. The losses caused by *ufra* are very heavy. In Begumganj thana in 1910 the loss was estimated at 200,000 maunds of grain and in Chaumuhani in 1911 nearly half the winter crop was lost. The disease has also been identified with the *sanhra* condition of paddy in the Khunti Sub-Division near Ranchi; further investigations will be carried out in this area.

An obscure disease of rice due to the attack of *Sclerotium Oryzae* Catt. was also investigated. This fungus has been found attacking rice in Burma, in Madras, and also in Bihar and Orissa, to which latter province it has been collected at Cuttack, Pusa and near Ranchi. Paddy infected by this parasite usually shows excessive tillering and

lightness in the grain, in fact there is frequently nothing within the glumes. In culture the morphology of the fungus proved more or less dependent upon the nature of the nutrient medium. The observations of Cattaneo, who regarded the sclerotia as spore containing organs, were not confirmed.

Brief accounts of Rice Bunt (*Tilletia horrida* Tak.) and False smut (*Ustilaginoidea virens* (Cke.) Tak.) were published in Bulletin No. 34. The former has been the cause of complaints from Germany, its spores having been found in rice imported from Burma and Siam. Effective remedies for this type of disease are known should the trouble become severe.

Sugarcane disease.—Complete accounts of the principal diseases of this crop were published during the year as memoirs of the Department.

"Red rot" has been the subject of previous publications of this section. In the most recent communication the authors have worked out the mode of airborne infection in the field, a point which had long been obscure. It was found that infection took place chiefly at the adventitious root eyes, although penetration was also easy at the shoot buds. The chief source of infection was the form of *Colletotrichum falcatum* which occurs on the mid ribs of leaves. The process of sett selection, described in previous publications, offers the best method of combating this disease. In districts where the local cane is badly diseased a fresh healthy type of cane should be imported and setts inspected carefully each year before planting. Fortunately in India we have a large range of these canes of hardy habit and great tillering power, which are relatively immune to red rot, and it has been found possible by hybridisation to combine the characters of such canes with those of the thicker, heavier yielding, varieties of other countries. The introduction of new and immune varieties of cane has been very successful in Bombay Presidency. The Imperial Mycologist visited Surat in October last and concluded that while the present state of the cane was good an outbreak of disease must be expected unless there is a marked improvement in local cultivation. At present the canes are grown in low lands and are practically water-logged. The adoption of the Godavari trench system or of the nursery system of cultivation common in Ganjam is recommended.

The wilt disease of sugarcane was found to be due to the attack of *Cephalosporium Sacchari* Butl., a hitherto undescribed species. This disease strongly resembles "red rot," but in the case of infection by airborne spores the plant was found to be far more susceptible to infection at stem wounds than in the previous case. The disease has been found at Surat, Poona, Samalkota and throughout North-eastern India. The control of the trouble should be on the same lines as in true

red rot. As, however, wound infection is more common the importance of removing diseased clumps before they have time to rot and set free spores is much greater. It is probable that this disease is incapable of doing permanent damage so long as the measures advocated against red rot, which are essential to the successful growing of thick cane in Northern India, are carried out.

"Collar rot" of sugarcane is due to the attack of *Hendersonina Sacchari* Butl., a hitherto undescribed genus. The outward symptoms are a withering of the top and a black rot of the roots; the lower nodes show a red discolouration in the pith. The roots and the base of the stem are full of the hyphæ of the fungus from which cultures are easily obtained. Both in cultures and on diseased canes a pycnidial stage was observed; the pycnidia are peculiar in containing two types of spores in the same loculus. Inoculations with pure cultures of the fungus were carried out at Samalkota and were successful in producing the disease. This disease occurs at Samalkota and at Jorhat. The extent of the damage caused by it is unknown.

Helminthosporiose of sugarcane is due to the well-known genus *Helminthosporium*, of which *H. Sacchari* Butl. is a new species. This fungus is common on the leaves of sugarcane in Pusa where it produces small red discolourations. Inoculations with pure cultures were successful. The damage done by this disease is at present negligible.

Smut of sugarcane (*Ustilago Sacchari*) has been under observation in the Central Provinces and culture work with this fungus is now in progress at Pusa. "Sereh" of sugarcane was reported at Jorhat and Coimbatore during the year. The Imperial Mycologist visited Coimbatore in October last and satisfied himself that "sereh" disease was not present.

Palm disease.—During the year an outbreak of bud rot took place among the coconut palms of Malabar and proved to be due to *Pythium palmivorum* Butl., the cause of the palmyra palm disease in the Godavari. The fungus was studied in pure culture for the first time and successful inoculations were carried out under sterile conditions in the laboratory. It was found that the fungus was particularly active in producing rows of spots on the young leaves of coconut palms. From such infections the fungus reaches the central bud by means of motile zoospores being washed down the leaves. Once the soft white leaf bases are reached a virulent rot takes place leading to the death of the tree. As the result of numerous observations on the discharge of zoospores it was concluded that the fungus probably belongs to the genus *Phytophthora* and not to *Pythium*.

Investigations upon *Fomes lucidus* (Leys.) Fr. were continued. The fungus is parasitic upon *Guazuma* and is probably the cause of a root rot of areca palms.

Rhizoctonia.—In January last there was a bad attack of disease on Pusa Farm due to this fungus. The crop affected was chiefly mustard, but the parasite was almost omnivorous. The fungus was *Rhizoctonia Napi* West—a species not previously observed in India. It is under observation in pure culture and appears to be incapable of growth at the temperature of the hot weather and rains in Pusa.

A rot of stored potatoes at Sabour and Bankipore was also due to *Rhizoctonia.* The species *R. Solani* Kühn was common and in one case a very bad rot was identified as due to *R. destruens* Tass. The latter fungus was also a virulent parasite on *Delphinium* at the Alipore Horticultural Gardens, Calcutta, in fact it was its occurrence on this plant which enabled it to be identified on the potato.

Cotton and Sesamum wilts.—An attempt was made to define the southern limits of extension of cotton wilt, which the previous year had been traced from the Central Provinces to Belgaum. It was found to be present very sporadically in Bellary District, presumably as an extension from the Dharwar side, but a careful search at Guntakal in Anantapur District and Nandyal in Kurnool District failed to show any trace of the disease. As no reports of its occurrence elsewhere in Madras have been received, it may be assumed that only the extreme north-west of the Presidency has been reached. On the other side typical cases have been received from the Nadiad Farm near Ahmedabad though the disease appears to be little prevalent in Gujarat. Cotton wilt is, therefore, present in the western part of the Central Provinces, practically the whole of Bombay, exclusive of Sind, and the north-west corner of Madras. It is severe in parts of the Berars and threatening in parts of Khandesh, but elsewhere, at present, does little damage. The cause was definitely established during the year to be a species of *Fusarium*, successful inoculations with pure cultures of the fungus having been secured. Through the kindness of the United States Department of Agriculture an opportunity was obtained of comparing the Indian cotton wilt fungus with *Fusarium vas infectum* Smith, the organism which is the cause of cotton wilt in America. There are considerable differences between the two parasites and it is probable that the Indian fungus is a distinct species. It is also probable, though accurate information on this point is not yet available, that the Indian disease is decidedly less virulent than that in the United States. India is fortunate too in possessing a race of cotton (buri) which is absolutely immune to the disease. Arrangements have been made, through Mr. Clouston, Deputy Director of Agriculture, Central Provinces (to whom the discovery of this property of buri cotton is due), to supply seed of this variety for trial in the United States in wilt infected tracts, and in return we are to receive American wilt-resisting varieties for trial in India. There is no other known method of fighting *Fusarium* wilts but by the growth of immune or resistant varieties.

Sesamum wilt has also been proved to be due to a *Fusarium*, and cross inoculations have confirmed what was already probable from morphological study, that the cotton and sesamum diseases are distinct and are due to distinct species of *Fusarium*. It is, in artificial inoculations, a much more virulent disease than the cotton wilt, proving fatal in every case tried in several hundreds. No resistant variety is known, but the cold weather (*rabi*) crop is less subject to the disease than the monsoon (*kharif*) varieties. Further work on these diseases will be resumed when opportunity arises.

Phytophthora investigations.—The potato blight *Ph. infestans* (Mont.) deBary was studied. It was discovered that the fungus does not survive in the heat of the plains of India and is not therefore likely to become a serious pest except possibly in the hills. A species of *Phytophthora* has also been discovered attacking *Vinca* and *Petunia*. It is a variety of the *Ph. parasitica* Dast. on castor, which has been the subject of a recent memoir. The slight variation in measurements and the few differences in the inoculation experiments may be accounted for by the influence of the host plant.

Miscellaneous.—Anthracnose of betel vine has been investigated and the perfect stage of the species of *Colletotrichum* has been proved to be an *Ascomycetes*. An inquiry was conducted into the rise in the exports of groundnuts. It was found that the re-establishment of the industry was dependent upon the introduction of early ripening exotic varieties which were not so susceptible to the tikka disease as the indigenous races.

Provincial Departments of Agriculture.—The following are the chief items of mycological work carried out by Provincial Departments of Agriculture and referred to in the reports published during the year:—

(1) **Bengal.**—The investigations into *ufra* disease of paddy have been described above. Present work is directed chiefly to the discovery of remedial measures and the delimitation of the infected area.

(2) **Bihar and Orissa.**—An account of the principal fungal diseases of crops in Bihar was published by Messrs. E. J. Woodhouse and Basu under the title of "Crop Pest Handbook for Bihar and Orissa." The *sanhra* disease of paddy at Khunti near Ranchi was found to be identical with *ufra;* the condition of paddy known as "chatra" is under investigation; it is probably due to the attack of *Sclerotium Oryzae* Catt. The treatment of potato with lime to prevent the spread of *Rhizoctonia* disease gave promising results and is being continued.

(3) **Bombay.**—Spraying operations against grape vine mildew and Koleroga of areca nuts have been continued, and demonstrations of sett selection against red rot of sugarcane have been carried out.

(4) **Central Provinces.**—The most important work during the year has been the breeding of varieties of wheat immune to rust and the distribution of the wilt resistant variety of cotton. The copper sulphate and hot water methods of combating smut were successfully demonstrated.

(5) **Madras.**—The research work during the past year consisted in the discovery of *Pythium palmivorum* Butl. as a virulent parasite of coconut palms in Malabar and its isolation in pure culture. The various campaigns against palm disease have been continued by the Government of Madras. In the Kistna District there has been a distinct abatement in the bud rot of the palmyra palm and the position in the Godavari is also more hopeful. The extension of bud rot into the upland taluks of the Godavari district is being carefully watched. A satisfactory feature is that by operation in the early stages of disease it has been found possible to save trees which otherwise must have died or been destroyed. In the Malabar district the bud rot of coconut palms has been promptly attacked on the lines of the operations in Godavari and Kistna districts.

Spraying operations against the Koleroga disease of areca nuts have been very successful in the Ponnani taluk of Malabar and in South Canara and are greatly appreciated by the local cultivators. In sprayed gardens the disease is sometimes almost entirely absent while untreated plantations contained 75—90 per cent. of diseased trees.

(6) **United Provinces.**—A curious disease of poppy has been under investigation. Two parasitic fungi—*Rhizoctonia* sp. and *Peronospora arborescens*—have been found upon the crop. It is doubtful whether either of these is the cause of the trouble. Work will be continued.

(7) **Mysore.**—Dr. Coleman has commenced the study of the spike disease of sandal wood and is also engaged in the investigation of the fungi parasitic upon green bug, *Lecanium viridi*. A new species of *Phytophthora* has been discovered upon figs, and spraying operations against the *Phytophthora* attacking areca nuts have been continued with market success.

(8) **Indian Tea Association.**—The Mycologist to the Indian Tea Association has continued his series of notes on the fungi parasitic on the tea plant—*Exoascus deformans*, *Rosellinia* and *Nectria Cancri* Rut. have been described.

II.—Systematic Mycology.

The systematic study of the large collections of *Deuteromycetes* (fungi imperfecti) in the Pusa Herbarium was taken up and material obtained for a fifth part of the Fungi Indiæ Orientalis. The series is being published in collaboration with H. and P. Sydow, Berlin.

A short paper appeared describing the complete stages of the rusts of sugarcane, figs and *Oldenlandia* and a list containing new species of Indian fungi was published in collaboration with M. P. Saccardo.

List of Publications.

Annual Reports of Agricultural Research Institute, Pusa, and of Provincial Departments of Agriculture.

BUTLER, E. J. .	Ufra disease of Rice. [*Agric. Journ., India, viii, July 1913* (also Bengali translation).]
" "	Diseases of Rice. (*Bull., Agric. Res. Inst., Pusa, No. 34, 1913.*)
" "	Tikka disease and the introduction of exotic groundnuts in Bombay Presidency. (*Agric. Journ., India, ix, January 1914.*)
" "	Notes on some rusts in India. (*Annales Mycologici, xii, 1914.*)
BUTLER, E. J., & A. HAFIZ KHAN.	Red-rot of Sugarcane. (*Mem. Dept. of Agri., India, Bot. Ser. vi, No. 5, October 1913.*)
BUTLER, E. J., & A. HAFIZ KHAN.	Some new Sugarcane diseases. (*Mem. Dept. of Agri., India, Bot. Ser. vi, No. 6, December 1913.*)
BUTLER, E. J., & SACCARDO, P. A.	Fungi Indici. (*Annales Mycologici, xii, No. 3, 1914.*)
MCRAE, W., & SHAW, F. J. F.	The Bud-rot of Coconuts in the Malabar District. (*Leaflet No. 10 of 1914 of the Dept. of Agri., Madras.*)
SHAW, F. J. F. .	Sclerotal disease of Rice. (*Mem. Dept. of Agri., India, Bot. Ser. vi, No. 2, July 1913.*)
" "	The Mahali Disease of Areca-nuts. (*Leaflet No. 7 of 1913 of the Dept. of Agri., Madras.*)
SHAW, F. J. F., & S. SUNDARARAMAN.	Bud-rot of Coconuts in Malabar. *Agric. Journ., India, April 1914.*)
SHAW, F. J. F., & S. SUNDARARAMAN.	Bud-rot of Coconuts in Malabar. (*Annales Mycologici, xii, No. 3, 1914.*)
TUNSTALL, A. C. .	Fungi parasitic on Tea. (*Quart. Journ., Scientific Dept., Indian Tea Assoc., Parts 1, 2, 1914.*)

AGRICULTURAL BACTERIOLOGY.

BY

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It is a regrettable fact that notwithstanding the acknowledged importance of this subject no results of any work upon it in the Provincial research laboratories have, with one exception, been published since their inception, nor could this gap have been filled in the absence of provision of qualified experts in soil bacteriology. One student has been through a two years' course at Pusa in order to take up the subject as bacteriological assistant to the Agricultural Chemist to the Government of the Punjab at Lyallpur, where biological analysis of "Reh" soils may provide useful information for dealing with this special problem; another student is now under training at Pusa for work at Nagpur under the Agricultural Chemist to the Government of the Central Provinces, and sanction has been obtained for a similar post in Bengal at Dacca; it is to be hoped therefore that a wider field of information on this subject may be opened up in the near future.

Green manuring.—The principal problem upon which work has been done on this subject at Pusa during the past year has been the use of green manuring, with special reference to the addition of nitrogen to the soil by this means and the availability or otherwise of this element when so added. The scheme of experiment as originally designed was intended to extend over a period of three successive seasons; interim annual reports were to be issued in the form of Bulletins, the final report to appear as a Memoir embodying the results and conclusions from the whole period. The first season's results were published as a Bulletin and those of the second year are ready for publication in the same form; it appears doubtful whether it will be advisable to conclude the experiments with those of the current or third year as it is abundantly evident that the information so far obtained forms but a small fraction of what may be derived from further study of the subject; it is also necessary to state that owing to untoward circumstances, the quantitative value of the field experiments of the first two seasons was greatly diminished, which makes it necessary to repeat the more important ones. The difficulty of obtaining an area of even soil for experimental plots was well illustrated in the first year when it was found necessary to discard the whole of one series on account of obvious initial differences between the soils of various plots; in the second year a carefully

selected area taken in the middle of a large field proved its unsuitability for anything more than comparisons between adjacent plots owing to water-logging of portions consequent on heavy rain and inadequate drainage. During the current year (1914) a fresh site has been selected which is free from such inequalities, but again difficulty has been experienced owing to irregular rainfall in June at the time of sowing and the attacks of caterpillars upon the backward plant; the latter has however survived and although the six weeks old crop weighs less than two-thirds of that of the same age in previous years it is hoped that reliable comparative results will be obtained. In addition to these field experiments on the farm, an area of one acre has been fenced in, cultivated, and sown with *Sannai*, on the south side of the new outside laboratory, and it is hoped that experimental plots on this area laid out in triplicate divisions of $\frac{1}{4}$th acre each, will help to provide controls for the field experiments carried out on a larger scale on the farm. In my previous Annual Report it was mentioned that the green manuring experiments for 1913-14 would include a trial of the use of the method of fermenting the green crop before applying it to the land, and at the same time concentrating the manurial action by restricting the treated area although using the whole of the fermented material. The result when such concentration was carried out, the fermented *Sannai* being returned to about half the area on which it was grown, in the case of the following *rabi* crop of wheat, was very apparent as a marked increase in crop, but owing to the waterlogging of part of the area and the consequent interference with the regularity of the series, definite quantitative conclusions could not be drawn as to the relative value of this method.

Small plots in the compound of the outside laboratory of about $\frac{1}{50}$th acre area were used for qualitative experiments in green manuring, the *rabi* crop being oats; variations in the method of preparing manure were tested and showed decided differences which are described in the report on the subject for 1913-14 now in hand. It was also found that for this oat crop on light soil, no apparent advantage was obtained by concentration of the manure, improvement of the crop being probably due to the comparatively high availability of the nitrogen content of the fermented material. Further experiments dealing with the application of the method to other crops such as tobacco are in progress during the current season. In connection with this work a considerable amount of research has been carried out in the laboratory in continuation of that of last year which dealt mainly with the ammonification and nitrification of the buried green crop; further observations on these two points have been made and in addition some fourteen species of bacteria, apparently closely connected with the decomposition of buried Sann hemp, have been isolated, and their physiological and morphological characters studied. It is remarkable that no one species of bacterium capable of attacking cellulose has been found so far in the general soil complex,

although the symbiotic relationship of two or more has been shown to produce this result; the opinion expressed in the Bulletin on green manuring published in 1914 that soil fungi probably played an important part in the breaking down of cellular tissue is strengthened by further observation; it is hoped that worked on soil fungi by the Mycological Section of this Institute may furnish valuable information on this point. Part of the study of the decomposition of green manure in the soil involved investigation as to the relative rates of formation of humus and nitrate; this enquiry has not yet arrived at the conclusive stage suitable for report. A considerable amount of work was done in connection with the changes taking place in fermenting green manure; the manurial value of this material appears to be due to the rapid formation of simple nitrogen compounds such as ammonia, from the proteid content; the nitrification of this ammonia, however, is interfered with by the fact of its concentration and also by the presence of soluble organic substances, some of which at least are strongly toxic to nitrifying bacteria and in less measure to others; this condition persists so long as the water extract remains acid to litmus which under ordinary conditions of manufacture might extend to as much as six weeks, and renders it necessary to study the conditions under which such manure can safely be applied to arable or other soil. The mode of preparation may also be varied considerably with corresponding differences in manurial action; such differences are apparently correlated with the rate at which the nitrogen content becomes available and are of importance in field practice with reference to the time of application, the nature of the soil, and the nitrogen requirements of the crop intended to benefit by the use of this form of manure.

It is interesting to note that the rapid ammonification which takes place when green manure is placed in water and allowed to ferment was found to be accompanied by the development of large numbers of ciliates, flagellates and amœbœ, whose presence does not appear in this instance to be prejudicial to the activity of ammonifying bacteria; it may be conjectured that under such conditions as obtain in this case the abundance of organic food would allow of a rate of reproduction amongst the bacteria which would more than counterbalance any phagocytic action on the part of the protozoa.

Nitrification.—The conditions under which nitrification takes place in soil have naturally formed an important part of the work of this section during this as in previous years; it was found in connection with numerous experiments made to determine the optimum moisture content for nitrification in various soils, that not only is the amount of water all important, but that the greatest amount of nitrification obtainable depends upon treatment, which takes into account the fact that ammonification is the necessary antecedent to nitrification in the case of organic matter, that this process is furthered by a high percentage of moisture,

that high concentrations of ammonia inhibit nitrification, but that such ammonia is absorbed by the soil and can then be nitrified. Experiment showed that the most rapid and complete nitrification of any given quantity of nitrogenous organic matter could be effected in soil by producing anaerobic conditions with water saturation and subsequently draining and aerating; the rapidity with which nitrification takes place under these conditions depends upon the relative completeness of the anaerobic and subsequently of the aerobic conditions. This was the case in all the soils experimented with but may not of course be of universal application. It was found that much more rapid ammonification took place in the case of organic matter kept under anaerobic conditions in soil than when free aeration was allowed, whether such anaerobic conditions were produced by water saturation, or by replacement of air by nitrogen or carbon dioxide, or simply by tightly closing the vessel containing the soil. At the same time toxins were produced which not only inhibited nitrification before the ammonia concentration was sufficient to do so, but afforded water extracts which were toxic to seedlings and to bacteria; subsequently aeration removes this toxic condition and the formation of nitrates takes place, the ultimate result being a high percentage of nitrification of the nitrogen of the organic matter; this apparently represents the cycle of changes in the case of the fermentation of green manure described above; its application to field practice is now being studied. In connection with the nitrification of green manures, it was found that a loss of nitrate invariably occurred between the 8th and 12th weeks of the process in the laboratory; a considerable amount of work has been done with the object of discovering whether this loss could be accounted for by correlating it with the gradual evaporation of soil water; the enquiry is not yet sufficiently complete for conclusive report, but it seems certain that the change noted is due to variation in the water content of the soil rather than to seasonal variation in the functions of the soil flora.

Experiments were made to determine the effect upon nitrification of varying the quantity of nitrogen as organic matter added to the soil; it was considered probable that any excess above the optimum would retard or even inhibit nitrification, but that the optimum might vary considerably with different soils and also in the same soil under different conditions. An unexpectedly high optimum was found for mustard cake in Pusa soil, namely, one per cent. of the soil weight, but it was shown that the high lime content of this soil was mainly responsible for these high figures, and that in soils such as the average tea soils of Assam, with less than one per cent. of lime, a much smaller quantity of cake would fail to nitrify at the normal rate. A study was made of the progress of decomposition of cake in soils varying in lime content, by periodic estimations of the loss on ignition, humus, ammonia and nitrates; it was found that decomposition was rapid in proportion to

natural growth on a starchy medium is accompanied by the secretion of diastase. The efficiency of a sample of Bákhar (which is made up and sold in the form of small greyish white cakes of about one ounce in weight) will therefore depend firstly upon its containing an efficient diastase-producing fungus, and examination has shown that the samples collected from various sources differ widely in respect to the kinds of fungi present and their correlated diastasic power with regard to rice starch. When the Bákhar cake is powdered and mixed with rice which has been prepared by moistening, the fungi present form a mycelial growth which involves the rice grains and gradually converts their starch into sugar, the completeness of this result depending upon the suitability of the conditions provided and upon the presence of fungi of adequate diastasic power. A large number of different species of fungi were found in various samples of Bákhar and the rapidity and completeness of the saccharification of the rice starch also varied in accordance with their relative diastasic powers which were measured in pure cultures. It may be said that no one of the numerous species found compared favourably in this respect with *Aspergillus Oryzae* which is the organism used for this purpose in Japan in the manufacture of " Sake " or rice beer, by the use of the preparaticn corresponding to Bákhar, known in Japan as " Koji;" it is possible that the introduction of *Aspergillus Oryzae* into India might considerably improve the rice beer of this country.

When by the action of the diastase-producing fungi a large proportion of the starch of the rice grain has been converted into sugar, mostly maltose, the next step is the fermentation of the sugar by yeast with formation of alcohol. In the very full and interesting account of the use of Bákhar by J. C. Ray published in the *Journal of the Asiatic Society of Bengal* (Vol. II, No. 4 of 1906) the author ascribes this alcoholic fermentation to the mucors which have already exerted a saccharifying influence on the starch; I have never failed, however, to find yeasts present in Bákhar capable themselves of producing alcohol without involving the supposition put forward that mucors in their vegetative condition secrete diastase but in the reproductive stage produce zymase, the alcohol producing ferment. The yeasts found varied just as the mucors and other fungi were found to do, and as it is a well-known principle in brewing and distilling that the variations in physiological characters of the yeasts involved require careful selection of the latter and exclusion of undesirable varieties, it is very probable that the haphazard introduction of unknown numbers of kinds of yeast into rice beer by the agency of Bákhar would afford another point over which control might usefully be exercised. A third point arises in connection with the use of Bákhar; as will readily be understood, when any organic matter such as moist rice is exposed to the air the ensuing fermentation is likely to be complicated by the presence and activity of bacteria; in the case of beer brewed in Europe from barley-malt and hops, the value of the latter

depends upon their content of lupulin with its associated "hop resins" which act as preventives of bacterial action; Bákhar contains many substances, the inclusion of which probably originated in an attempt to prevent putrefactive changes, although now they form merely parts of the tradition or trade secret handed down without knowledge of their specific function, or of the fact that whilst the mouldiness aimed at is produced by fungi, the putrefaction sometimes resulting is due to bacteria. Chillies, ginger, and the bark and roots of various plants are among the substances incorporated with the ground rice to form the Bákhar cakes; so far the function of the various substances examined appears to be to restrict the growth of bacteria during the earliest stages of infection of the rice to be fermented until the growth of the mucors has become strong enough to suppress bacterial competition, and in this respect they resemble the hop resins in action. Many of the substances added to Bákhar by the makers are no doubt intended to produce other effects which would, however, be confined for the most part to the beer and would not appear in the distilled spirit; it has been reported that Datura and Nux Vomica are sometimes used in this way and it is natural to suppose that the reputation of a Bákhar maker might be enhanced amongst a certain class of his clients by such reprehensible practices. Specimens of a plant, said to be a necessary ingredient of Bákhar as made in the Darjeeling district, have been sent to me for examination; this plant is known to the Limboo tribes as "Wadinghangma" and to the Nepalese as "Bhimsen pati;" it has been identified by the Curator of the Lloyd Botanic Garden in Darjeeling as *Polygala arillata;* the bark of the roots affords a decoction the antiseptic properties of which are now under examination.

Biological analysis of soils.—*Reh soils.*—Samples of "Reh" soil received from the Agricultural Chemist to the Government of the Punjab were under biological examination and formed a subject of study for Mr. Barkat Ali, a student from the Punjab who was undergoing training in soil bacteriology in this section. Several interesting facts were discovered as to the effect of lixiviation upon the flora of these soils, and the conclusion was arrived at, that the normal processes of ammonification, nitrification and nitrogen-fixation would be the natural consequence of removal of the excess of salts from the soil by this means.

Biological analysis of soils from Cawnpore, Sind, Assam and Nepal were carried out and reports upon them furnished; the method used is still under revision owing to the necessity for variation in accordance with the character of the soil and the information desired.

Publications.

HUTCHINSON, C. M. . Green Manuring Experiments, 1912-13. *(Bull. No. 40 of 1914.)*

FORESTRY.

I.—SYLVICULTURE.

BY

R. S. TROUP, F.C.H.,

Sylviculturist.

Statistical work in typical forest crops.—The work of establishing permanent and temporary sample plots in typical forest crops, with the view of obtaining statistics relating to volume production, was continued in the United Provinces and the Punjab. Altogether 27 permanent plots and a number of temporary plots were laid out during the year, the species dealt with being *Shorea robusta*, *Dalbergia Sissoo*, *Pinus longifolia*, *Pinus excelsa*, and *Cedrus Deodara*. Since the commencement of this work in 1910-11, altogether 171 permanent sample plots have been laid out; of these 122 are in the United Provinces, 47 in the Punjab and 2 in the Forest Research Institute experimental ground at Dehra Dun. Quinquennial remeasurements will commence in 1915-16, after which a commencement will be made in the compilation of results for practical use: the financial working of the more important forest crops should thus be placed on a more rational basis than is at present possible.

The Sal tree (Shorea robusta).—The sylviculture of the *sál* continues to form one of the main items of research. An important series of experiments, dealing with the natural regeneration of this species, was commenced with the co-operation of Local Forest Officers in different parts of India. These experiments consist in the demarcation of small plots of natural regeneration in various localities and under every possible variation of natural conditions, the object being to ascertain the time taken for *sál* seedlings to establish themselves under different natural conditions and commence to produce regular increment. Altogether 152 of these plots are now under observation, these being distributed among three Provinces, Assam (40), Bengal (5) and the United Provinces (107).

In the *Indian Forester* of April 1914 Messrs. Grieve and Shebbeare draw attention to the unforeseen results of continuous fire protection in the Duars *sál* forests of Bengal, namely, the production of a hitherto non-existent type of forest with an evergreen undergrowth which effectually prevents the establishment of *sál* regeneration in spite

of repeated cleanings: on the other hand instances are quoted of excellent regeneration on areas until recently subjected to annual burning. Experiments are in progress to ascertain the value of *Mallata* (*Macaranga*, sp.) as a nurse to assist in the establishment of *sál* regeneration: failing the success of these experiments and authors are convinced that the only means of obtaining successful regeneration is to carry out heavy seed-fellings and follow the opening of the canopy by successive annual burnings until the young *sál* crop is established. This procedure appears to be indicated on the ground that in the Duars proper (excluding the hill slopes) *sál* regeneration establishes itself on burnt savannahs.

Sylvicultural experiments at Dehra Dun.—In the Sylvicultural gardens at Dehra Dun experiments continue to be conducted with a view to determining the requirements and treatment of some of the more important Indian trees, particularly as regards their natural reproduction, their demands on light and moisture, and their artificial propagation by seed, cuttings and rootsuckers. Different methods of sowing and planting, including sowing in combination with field crops, are under trial, while the influence of nurses on the establishment of *sál* seedlings forms the subject of a series of experiments.

Questions of regeneration are intimately connected with the treatment which the seed receives in Nature before germination, and the manner in which the seed germinates and the seedling develops: a detailed study of the germination of seed and the development of seedlings, therefore, is of the utmost importance in sylviculture. Investigations on these lines have been proceeding for some time past, and will continue to be conducted, in respect to most of the important trees of India.

Developments in sylvicultural systems.—The introduction of improved sylvicultural systems continues to form an important item of research, and a number of experimental fellings have been carried out during the year, chiefly in the coniferous forests of the Himalayas, where conditions approximate more closely to those of European countries than do the conditions obtaining in the broad-leaved forests of the rest of India: the Thano *sál* forest near Dehra Dun continues to be worked experimentally under the system of successive regeneration fellings, and the results so far are promising.

But apart from merely experimental work, there are serious efforts on foot in various localities to introduce improved methods of working high forest by concentrating regeneration operations on definite areas. On the whole the working-plans published during the year show but little tendency towards such improvement, though there are various plans now under compilation which will, when ready, contain pre-

scriptions showing a marked development in the management of high forest.

Of the working-plans published during the year Mr. Blanford's plan for the Mosit teak forest, Burma, presents to some extent a departure from the stereotyped plans of that province, in that special efforts are to be made in the establishment of teak regeneration by the concentration and frequent repetition of improvement fellings over definite blocks. Otherwise the selection system is adopted for the present, though it is realized that a more uniform system of management may be found advisable later. Under Mr. McIntosh's working-plan for the Dalhousie Range, Chamba State, the system of successive regeneration fellings is prescribed for forests of *Pinus longifolia;* this, however, is no new departure in forests of this species. Mr. Srinivasulu Naidu in his working-plan for the Buldana Division, Berar, prescribes the working of *Acacia arabia* under the clear-felling system with artificial reproduction, a system commonly followed in the case of this species. In the other published working-plans high forest is subjected to treatment by selection or improvement fellings.

Sylvicultural Publications during 1913-14.

AITCHINSON, P. E.	. Sirsi Town Working-plan, Bombay Presidency.
BELL, C. F. .	. Working-plan for the Reserved Forests of the Nimar District, Central Provinces.
BLANFORD, H. R.	. Mosit Working-plan of the Bhamo Division, Burma.
CHANNER, F. F. R.	. Supplement to the Working-plan for the Tarai and Bhabar Government Estates Protected Forests dealing with the Tanakpur portion of the Estates, United Provinces.
DICES, A. R. .	. Working-plan for the Chakaria Sunderbans Reserve, Chittagong Division, Bengal.
FOULKES, F. .	. Teak in the Wynaad. (*Ind. For., xl, 173, 241, 315.*)
GLOVER, H. M.	. Departmental Firing in the *Chir* (*Pinus longifolia*) Forests in the Rawalpindi Division, Punjab. (*Ind. For., xxxix, 568, xl, 292.*)
GRIEVE, J. W. A., & SHEBBEARE, E. O.	Sál Regeneration in the Duars Forests. (*Ind. For., xl, 147.*)
JERRAM, M. R. K.	. The Concentration of Regeneration Operations. (*Ind. For., xl, 141.*)

McIntosh, R. . . Revised Working-plan for the Dalhousie Range Forests of the Chamba State, Punjab.

Parker, R. N. . *Prosopis Juliflora*, DC. (*Ind. For., xxxix, 320.*)

Smythies, E. A. . Sylvicultural Systems of Regeneration in Chir Pine Forests. (*Ind. For., xxxix, 514.*)

Srinivasulu Naidu, S. Rao Bahadur. Working-plan for the Buldana Forest Division of the Berar Circle, Central Provinces.

Tireman, H. . . Working-plan of the Eastern Forests of Coorg.

Witt, D. O. . . Garhakota High Forest Working Scheme, Central Provinces.

Wright, H. L. . Report on the Eucalyptus Experiments in the Simla Forest Division for the year 1912-13.

II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, I.F.S., F.L.S.,
Forest Economist.

Economic uses of *sal* timber.—This enquiry has been completed, with the exception of those portions dealing with the relative strength of timber cut at various periods of the year and the seasoning qualities of the same. As *sál* timber takes a long time to season it is not expected that these experiments will be completed for several years.

Economic uses of Deodar timber.—A similar investigation to that which has been carried out into the uses, physical and mechanical properties, outturn and prices of *sál* was undertaken at the commencement of the year in respect to *Deodar* timber. Figures of outturn and prices have been collected, the uses to which the timber can be put have been recorded, experiments to ascertain the specific gravity of the timber have been commenced, while trees have been felled in various localities and growing at different elevations from which logs have been prepared and laid down to season. In due course these logs will be converted and the timber tested for shearing, compression, transverse strain and toughness.

Grasses for use as paper pulp.—To further this enquiry two sample lots of grass were tested on a commercial scale by two large Indian paper-pulp mills. The results obtained by testing 500 maunds of *Phragmites Karka* were not encouraging, the reason for this is attributed to the grass having been cut at the wrong time of the year. The second set of tests were carried out on *Anthisteria gigantea* Cav; these also gave unsatisfactory results, which in Mr. Raitt, the Cellulose Expert's opinion was due to faulty treatment.

The results obtained, though giving negative answers, are in themselves instructive and clearly show that though possibly such grasses may be of great commercial value, the enquiry will have to be carried out on different lines. It is thought that probably the most satisfactory way of dealing with this enquiry will be to follow the lines on which the bamboo pulp enquiry was prosecuted with successful results.

Match wood.—The match industry in Northern India may be said to be passing through a new phase. In the past Indian match makers have relied largely on *Bombax malabaricum* timber for making both boxes and splints. This timber makes up into a strong serviceable

box, but it cannot be classed as a superior splint wood. The chief disadvantage of *Simul* for splints is that the wood discolours and does not cut up into a square stick, hence the difficulty of obtaining uniform heads to the matches. Besides the above defects owing to cross grain the splints break. To overcome these difficulties match makers are investigating the possibilities of utilizing Spruce and Silver fir timber, which makes up into first class splints. From enquiries made by persons interested in this industry the outlook in this direction is decidedly encouraging.

Antiseptic treatment of timber.—The enquiry as to the value of treating timber with antiseptics was vigorously prosecuted during the year. The experiments which have been in progress during the last five years and which consisted in treating five different species of timber with four different antiseptics, were practically brought to a conclusion during the last working season. The first set of experiments consisted in powellizing 3,000 sleepers, including two Pines, two Dipterocarps and *Terminalia tomentosa*, the following year's experiments consisted in treating sleepers of the above species with *Avenarius Carbolineum* oil, in the third year's experiments chloride of zinc and green oil were used, and during the year under report the sleepers were treated with *Solignum* and Liquid Fuel oil mixed. The sleepers after treatment have been handed over to the State Railways, laid in the line and periodically inspected. The treated sleepers have not been in the line sufficiently long to enable a definite statement being made as to whether they will answer under Indian conditions, though up to date the sleepers are doing quite well. Those treated by the Powell process have now been in the line nearly three years; in this connection it is interesting to compare the behaviour of untreated sleepers of the same species, laid down in the same locality. In 1906 one thousand *Pinus longifolia* and one thousand *Pinus excelsa* untreated sleepers were laid down between Hardwar and Lakhsar, Oudh and Rohilkhand Railway, and had all to be rejected within 27 months, while of the 260 powellized sleepers of the same species, laid in the same locality, none have been removed in 32 months.

Much time and labour has been expended in rendering all help possible to the officers in charge of the United Provinces sleeper treating plants, in which it is proposed to treat over a million B. G. *Pinus longifolia* sleepers with green oil and Liquid Fuel oil for the State Railways. This has involved visits to the treating centres at Tanakpur, Kathgodam and Hardwar, carrying out experiments to ascertain the amount of absorption, the necessary periods of immersion, temperatures at which the sleepers should be treated and a variety of similar information. The scheme may be said to be progressing favourably, though many difficulties have been encountered, which is to be expected when carrying out so large an undertaking.

In order to test the value of the Rueping process arrangements have been made to send to Europe 72 sleepers of 9 different species to be tested, while a further scheme is under consideration to creosote certain Dipterocarp species under pressure.

Tea-boxes.—In last year's report an experiment was foreshadowed by which it was proposed to send home tea in treated shooks, in order to ascertain whether the tea became tainted by being packed in such boxes. The idea of treating the boxes was carried out with a view of enabling the saw-mill managers and tea-planters to store shooks against demand without fear of insect attack. The experiment was successfully carried out and the report from Home showed that the tea was in no way affected. As full sized boxes can be treated at a cost of about 9 pies and as it has been proved that such treated shooks are not attacked by borers for at least one year, the results obtained may be of considerable value to the trade and have therefore been published.

Tan barks.—This enquiry was restricted to obtaining further information as to outturn, prices and conditions of locality in connection with mangrove barks of Burma. The data collected show that large quantities are available from the Arakan, Mergui and Tavoy Districts, that they can be exploited at a reasonable cost and that the local conditions are generally favourable for erecting a factory. The Director of the Imperial Institute, London, having all available information at his disposal, is endeavouring to interest a firm in this business.

Physical and mechanical properties of certain timbers.—(*i*) *Identification of Dipterocarp timbers.*—Experiments were carried out in the laboratory to try and find a ready method of distinguishing *Dipterocarpus alatus*, *Dipterocarpus tuberculatus* and *Dipterocarpus turbinatus* one from the other by staining the timber, the idea being to obtain different densities of colour by reaction on the varying amounts of oleo-resin contained in each species of timber. The results obtained were fairly satisfactory and they are now being put to a practical test in the field.

(*ii*) *Seasoning of timber.*—It was determined during the year to make a preliminary enquiry as to the best methods of seasoning timber. With this object in view information was collected from the Forest Department, from timber merchants, saw-mill managers, and firms working in timber, on the methods in vogue and with respect to past experiments; at the same time, Conservators were asked to express their opinion as to the lines on which the future enquiry should be carried out. On the reports received a complete note on the proposed enquiry comprising the whole of India and Burma has been drawn up, and a commencement has been made to carry out the provisions of the scheme. As timber seasons slowly no definite results can be expected for several years.

(*iii*) *Water-logging of teak.*—At the request of one of the leading firms in Burma dealing in teak, an enquiry of considerable interest was carried out to ascertain why certain teak logs became water-logged and sunk while being floated out. It was found that the sunken logs contained upward of 42 per cent. of moisture. Specimens prepared from these logs after being seasoned showed the specific gravity of the timber to be normal, the growth of the trees was also normal, though the percentage of the tar oils was in defect. To overcome this water-logging it was suggested to the firm that they should drag the sunken logs out of the water, allow them to season thoroughly, and before relaunching them to apply "Ligno" or "Loracine" to the ends to retard re-absorption of water. This the firm have agreed to do and it will be of interest to hear next rains how these logs have fared.

(*iv*) *Water-logging of Pinus longifolia.*—A similar enquiry was carried out at the request of the United Provinces Forest Department with Chir sleepers, which had sunk while being floated out. In this case the timber was found to have only ·98 per cent. of resin in it, as against 10 per cent. to 12 per cent. or more in normal timber. No doubt the absence of resin allowed the timber to absorb water more readily than is the case when the percentage of resin in the wood is about normal.

(*v*) *Testing timber for mechanical strength.*—A series of tests were carried out on various species of *Grewias* and also on certain possible suitable sleeper woods in order to ascertain their strength to withstand shearing, compression and transverse strength. Tests were also carried out on teak and Oregon pine on behalf of the Oudh and Rohilkhand Railway.

Finding new markets and uses for timber.—With a view of furthering this object, twelve Forest Bulletins have been issued dealing chiefly with uses, outturn and market value of more important species found in the State Forests. During the year information has been collected on six other species and the Bulletins are now in course of being compiled.

A very successful experiment was carried out to introduce *Heritiera minor* timber from Burma to the Calcutta market, by sending some ten tons of converted material and timber in the log from the Bassein Division as a trial consignment. It sold for exceptionally good prices owing to the large sizes available, so that in future there should be no difficulty in disposing of this timber on the Indian market.

Gums, resins and oleo-resins.—The *Boswellia serrata* gum-resin enquiry was pushed forward a step by an experiment carried out in Nimar by Mr. Benskin, Assistant to the Forest Economist. The difficulty in the past has been in finding the best method of tapping the trees. He selected sample plots in various localities, totalling to 49·2

acres in all, and tapped all trees of over 24″ girth. The yield per tree per month worked out as follows:—

	lbs
24″ girth	·43
30″ girth	·57
36″ girth and over	·77
Average	·59

In a working season of five months a tree would therefore yield 3 lbs. As an example of outturn it may be stated that the East Khandesh Division alone reports 11,000,000 mature trees, so that the total amount available of this gum-resin is considerable. Samples of the gum-resin were treated in a specially designed still in the laboratory at Dehra Dun, and samples of the turpentine, essential oil and rosin submitted to the Imperial Institute, London, the reports on which are awaited with interest.

During May, June and part of July 1913, the Forest Economist helped the Divisional Forest Officer, Naini Tal, to design and erect the new Government Turpentine and Rosin Factory at Bhowali. The distillery is now in full working order. In January and again in June 1914 the Chemical Adviser and the writer again visited the distillery to standardise the new plant when working with stored and fresh crude resin respectively and prepared notes for the guidance of the Local Officers on the results of their investigation.

An enquiry into the uses, outturn and market value of *Melanorrhœa usitata* was carried out by Mr. Benskin, Assistant to the Forest Economist, and a note prepared for publication on the subject.

Solvent and steam extraction of rosin and turpentine from *Pinus longifolia* timber.—An interesting experiment was carried out by sending home 100 lbs. of *Pinus longifolia* branch and stem wood to ascertain the yield of turpentine and rosin, when worked on a commercial scale. The idea underlying this experiment was to find a use for the timber which grows in the Almora District of the United Provinces and which owing to its twisted nature is valueless for timber. The wood was sent to a large Sheffield firm, the report was on the whole satisfactory, the yield of turpentine by action of steam on chipped wood being 8·5 per cent. while the yield of rosin extracted with the help of a solvent amounted to 12 per cent. A preliminary note has since been prepared showing a profit and loss amount on such an undertaking, which shows that the subject is worthy of further consideration.

Cement barrels.—Some 14 species of timber were sent home in the log at the instigation of a Bombay firm to be tested for cement

barrels, with the result that the following were reported on as being eminently suitable and superior to the Swedish and Norwegian timber used for the purpose:—

(1) *Stephegyne parvifolia*, (2) *Saccopetalum tomentosum*, (3) *Sterculia urens*, (4) *Grewia tiliæfolia*, (5) *Adina cordifolia*, (6) *Albizzia odoratissima*.

Fibres.—Several maunds of *Heliteres Isora* fibre were sent to a Dundee firm from three divisions of the Central Provinces. The reports on this fibre varied considerably, it being valued at anything from £7 to £14 per ton. An offer was made for a fairly large consignment at £7 per ton, f.o.b. Glasgow, which was not accepted. Until a better method of preparing this fibre can be discovered it will be difficult to place it on the market.

Paving blocks.—An enquiry was started during the year and is now in progress to utilize the waste ends resulting from the conversion of *sál* sleepers by cutting such waste pieces up into paving blocks. In this connection arrangements have been made to supply the Chief Engineer, Calcutta Corporation, with 50 tons of prepared blocks, free of cost, with which to lay a portion of a road as an experiment. A similar amount of paving block timber of *Xylia dolabriformis* from Kanara will also be supplied, after treatment in a Creosote oil, to the Bombay Municipality for experimental purposes.

Woods for railway wagons.—Samples of *Terminalia tomentosa*, *Terminalia paniculata* and *Lagerstrœmia microcarpa* were sent to the Superintendent, Carriage and Wagon Works, Ajmer, to be tested for wagon bottoms and doors. The former was found suitable for doors, but none were pronounced suitable for the bottom of ballast trucks.

Economic and wood museums.—A considerable number of specimens were added to the museums, amongst others a fine collection of New Zealand woods. The collection of large specimen planks was enlarged by the addition of several fine examples. During the year a large number of timber specimens and also specimens of other forest products such as seeds, fruits and fibres, etc., have been supplied by this office to private firms, individuals and institutions, etc., in India, England, Australia and America.

A large number of specimens were received from the Conservators of Forests in the various provinces for the Research Institute Museums, and for the experimental purposes.

List of Publications and Articles on Forest Economic matters published during 1913-14.

BAILEY, J. W. . . The Preservative Treatment of Wood.

BAKER, R. T. . . Cabinet Timbers of Australia.

BENSKIN, E. . . . A Possible Substitute for Shellac. (*Ind. For., xxxix, 825.*)

BRYANT, R. C. . . Some Methods of securing Closer Utilization. (*Amer. Forestry, xix, 571.*)

BUTTERWICK, A. J. . The Bamboo Forests of the Pegu Forest Division and the Method of extraction. (*Ind. For., xxxix, 176.*)

CHIPP, T. F. . . A list of Trees, Shrubs and Climbers of the Gold Coast, Ashanti and the Northern Territories.

CLINE, MCGRAVEY, & HEIN, A. L. Tests of Structural Timbers.

CORRIE, MACKIE & CO. Commercial Opinion on the Fibres of *Urena lobata* and *Calotropis procera*. (*Ind. For., xxxix, 437.*)

GROOM, PERCY . Critical Identification of the Wood of Indian Pines. (*Ind. For., xxxix, 409.*)

GROOM, PERCY, & RUSHTON, W. The Structure of the Wood of East Indian Species of Pinus. (*Journ. of Linnean Society, Botany, xli, 1913.*)

MISRA, C. S. . . The Cultivation of Lac in the Plains of India. (*Tachardia lacca*, Kerr.) (*Agri. Resch. Instt., Pusa, Bull. No. 28, 1913.*)

MOORE, BARRINGTON. Turpentine in Forests under Management. (*Amer. Forestry, xix, 219.*)

PATERSON, J. H., & FORRESTER, R. E. The Fractional Distillation of mixed Pine Woods. (*Journ. of the Soc. of Chem. Industry, xxxii, 1053.*)

PEARSON, R. S. . Note on the Treatment of *Terminalia tomentosa* Sleepers in the Betul Division, Central Provinces with chloride of zinc and Avenarius Carbolineum oil. (*Ind. For., xxxix, 378.*)

" " . . Note on the Mangrove Bark for Tanning. (*Ind. For., xxxix, 545.*)

" " . Note on the Tapping of *Boswellia serrata* trees in the Siwalik Division, United Provinces. (*Ind. For., xxxix, 196.*)

" " . Note on the Possibility of exporting Pyinkado Sleepers from Burma for the use of Indian Railways. (*Ind. For., xxxix, 256.*)

PEARSON, R. S. . . The Tea-box Industry in Assam. (*Indian Planters' Gazette, lxi, No. II, 376.*)

PURAN SINGH . . A short Note on the *Terminalia tomentosa* bark as a material for the manufacture of Tannin Extract. (*Ind. For., xxxix, 423.*)

" " . . Note on the Indian Oak barks as materials for the manufacture of Tannin Extracts. (*Ind. For., xxxix, 420.*)

" " . . Note on Turpentines of *Pinus Khasya, Pinus Merkusii* and *Pinus excelsa.* (*For. Bull. No. 24, 1913.*)

RECORD, SAMUEL J. . Prolonging the Naval Stores Industry. (*Scientific Amer., cx, No. 9, 173.*)

ZOOLOGY.

I.—GENERAL ZOOLOGY AND PHYSICAL ANTHROPOLOGY.

BY

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Introduction.

This report, like that of last year, deals primarily with zoological work undertaken in the Zoological and Anthropological Section of the Indian Museum, but for the first time I have included notes on anthropometrical investigations, becase it is the first year, at any rate since the institution of these reports, that work of the kind has been attempted in the Museum. Zoological work with a direct bearing on the fauna of India that has been undertaken elsewhere is dealt with briefly, so far as published results are concerned, in the note prefixed to Dr. Chaudhuri's list of publications on page 134.

Centenary of the Indian Museum.

The Indian Museum, in which zoology has always taken a very prominent place, has this year celebrated the centenary of its foundation by the Asiatic Society of Bengal, to which we owe ultimately most of the scientific departments in India. A special exhibition was instituted by the different sections in honour of the event, and among the zoological exhibits were displayed representative collections of the deep-sea animals dredged in Indian seas by the R.I.M.S. "Investigator," of the freshwater invertebrates recently discovered by officers and correspondents of the Indian Museum, and of those of the Sea of Galilee obtained on a special expedition by myself. Exhibits illustrating the biology of insects, the taxonomy of Indian Diptera and the fisheries of Bengal were also prepared, the last two by Mr. E. Brunetti and Mr. T. Southwell, Deputy Director of Fisheries, Bengal, and an Honorary Assistant in the Museum. Other zoological and anthropological exhibits included a series of the fauna of the Abor country, and one of photographs of the Abors themselves taken by Mr. S. W. Kemp of the Museum and Mr. J. Coggin Brown of the Geological Survey. Last, but not least, in interest amongst the exhibits of the section were a large number of zoological drawings by the artists of the Museum and the Marine Survey, Babus A. C. Chowdhury, D. N. Bagchi and S. C. Mondul.

The First Indian Science Congress.

The first meeting of the Indian Science Congress was held in Calcutta at the same time as the celebration of the Museum Centenary and was attended by zoologists from Madras, Lahore and Bombay as well as residents naturalists. Several interesting zoological papers were read and discussed. The date on which the Congress opened was the 130th anniversary of the foundation of the Asiatic Society.

ZOOLOGICAL WORK OF THE MUSEUM.

Collections.

The re-arrangement of the collections of aquatic invertebrates referred to in last year's report has greatly facilitated reference and has rendered comparatively easy a considerable amount of research that could not previously have been undertaken without great labour. Similar work is now in progress on the collection of Molluscs.

Among numerous additions to the zoological collection as a whole the most importance are the following:—

(*a*) The specimens obtained in the Chilka Lake by members of the staff.

(*b*) The marine specimens received from the Surgeon-Naturalist, Indian Marine Survey.

(*c*) A collection of mammal skins received from the Bombay Natural History Society in accordance with an agreement made by that Society with the Government of India.

(*d*) Collections, mostly of freshwater invertebrates, from Kashmir presented by Colonel F. Smith, R.A.M.C., and by Messrs. C. S. Middlemiss and H. L. Bion of the Geological Survey of India.

(*e*) Helminthes, chiefly tapeworms and nematodes, presented by Mr. T. Southwell or obtained by him from animals that died in the Calcutta Zoological Gardens and were presented by the Committee of Management.

(*f*) Collections, mainly of invertebrates and Batrachia, from the hills of Ceylon made by Mr. S. W. Kemp while on leave and presented by him.

Mr. F. H. Gravely, Assistant Superintendent, submits the following report on the entomological collections. It covers only the period of the financial year 1913-14.

"**Scorpionidea.**—Dr. K. Kraepelin of Hamburg has finished his work on the specimens of this group and has returned them to us.

Chernetidea.—Mr. E. Ellingsen's paper on our collection has now been published in the 'Records.'

Araneæ.—The spiders of the Abor Expedition are still with Dr. Nathan Banks in America.

Phalangidea.—Dr. C. Roewer* continues to determine at Bremen all Phalangids added to our collection. The Abor collection has been received back from him during the year.

Acari.—We have ceased for the present to collect ticks from ordinary domestic animals in Bengal, as we no longer find anything fresh among them. Consequently very few ticks have been collected during the year. We are, however, still in communication with Prof. G. Nuttall and Mr. C. Warburton of Cambridge.

Thysanura.—Dr. F. Silvestri is still working at this order for us, but no fresh material has been sent to him since his recent prolonged absence from his laboratory in Italy.

Collembola.—Dr. G. H. Carpenter still has in Dublin the Collembola of the Abor Expedition.

Orthoptera.—Dr. Malcolm Burr is still working on our Dermaptera, in England. Dr. E. Giglio-Tos of Cagliari has reported on the Mantidæ and Phasmidæ of the Abor Expedition, but has not yet returned the material. Mr. H. S. Leigh still has the material sent to him at Manchester some time ago. Dr. J. L. Hancock of Chicago has returned the Tettiginæ of the Abor Expedition and now has the rest of our material in this group. Dr. A. Griffini of Milan has worked out the whole of our collection of Gryllacrinæ and Stenopelmatinæ and has returned the material to us.

Termitidæ.—Nothing has been sent to Prof. Silvestri for some length of time, owing to his absence from home, and we have arranged for Father J. Assmuth of Bombay to examine our Termitidæ. Since his return Prof. Silvestri has described several new species from the material previously sent him.

Mallophaga.—Prof. V. L. Kellogg of California has sent in a report on our collection, but has not yet returned the material.

Odonata.—Dr. F. F. Laidlaw has returned the dragon-flies of the Abor Expedition. Prof. J. G. Needham of Ithaca, United States of America, informs us that he is sending on to Dr. Laidlaw all the dragon-flies we sent him some time ago. We are getting the rest of the collection of dragon-flies packed up so that it may go to Dr. Laidlaw as soon as possible.

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* This report was of course written before the outbreak of war.

Neuroptera (*sensu lato*).—Nothing more has been received from Prof. J. G. Needham. Dr. Nathan Banks has returned the Neuroptera of the Abor Expedition.

Trichoptera.—Nothing more has been received from Dr. C. Betten.

Hymenoptera.—Col. C. G. Nurse, Bury St. Edmunds, has reported upon the wasps of the Abor Expedition. Dr. S. A. Rohwer of Washington, Dr. W. M. Wheeler of Boston and Mr. Claude Morley are still working for us, and Mr. Morley recently returned a number of specimens.

Coleoptera.—My catalogue of the Passalidæ in the collection is still in the press. During my absence in Europe I was able to extend my investigations considerably and to make a number of important additions to the collection, which is now a remarkably complete one as regards Oriental species and Indo-Australian genera.

Herr H. E. von Krekich-Strassoldo of Trieste has returned our Anthicidæ after identifying them and has added several new species to the collection. Herr H. Wichmann of Waidhofen, Austria, has returned the Ipidæ of the Abor Expedition with a report upon them; and Herr H. Bickhardt of Cassel has finished our Histeridæ and has returned the collection. Mr. G. J. Arrow of the British Museum, Dr. Joseph Gillett of Brussels, Dr. W. Horn of Berlin, M. A. Grouvelle of Paris, Dr. Max Bernhauer of Grünburg, M. P. Lesne of Paris, Herr S. Schenkling of Berlin, Mr. W. Creighton-Wellman of New Orleans, Herr F. Borchmann of Hamburg, Mr. S. Maulik of Cambridge, Messrs. C. J. Gahan and G. A. K. Marshall of the British Museum, Dr. H. Kolbe of Berlin, Dr. A. d'Orchymont of Menin, Belgium, and Herr W. Wagner of Berlin are still working on our collections. The remainder of our Apioniæ have now been sent to the last-named specialist. In addition we have sent the remainder of our Ipidæ to London to Col. F. Winn-Sampson; our Opatrinæ to Mr. K. G. Blair of the British Museum; the Dytiscidæ of the Abor Expedition and all our Gyrinidæ to Dr. K. Ahlwarth of Berlin; specimens of genus *Sagra* to Dr. H. Kuntzen in Berlin; and specimens of the genus *Helota* to Dr. C. Ritsema of Leyden. The *Helotæ* have already been received back named. Herr H. Gebien of Hamburg, under whom I was sent to study Tenebrionidæ, has named a number of specimens of this family for us and has given me invaluable assistance with the Abor collection of the family. I am still working on the material.

Lepidoptera.—Captain W. H. Evans, R.E., has again worked on our butterflies during a visit to Calcutta. Both he and Colonel H. Tytler have presented us with a number of specimens during the year. Some of the Bornean Lycænidæ lent to Mr. J. C. Moulton were unfortunately lost in the post on their return from London. The valuable collection of moths purchased from Mr. E. E. Green, late Government Entomologist, Ceylon, and referred to in last year's annual report, forms a most useful

addition to our collection of Lepidoptera. It contains specimens of 635 genera and 1,790 species.

Diptera.—Mr. E. Brunetti, Dr. J. J. Kieffer of Bitsche, Dr. B. Lichwardt of Berlin and Prof. M. Bezzi of Turin are continuing their work on our flies. Of the two families dealt with by Dr. Lichwardt, one, the Nemestrinidæ, has been returned; Miss G. Ricardo of London has returned the rest of the Tabanidæ sent her; and Prof. P. Speiser of Labes, Germany, informs us that he has at last sent off the Diptera Pupipara, but they have not yet reached us. Mr. F. W. Edwards of the British Museum has identified all our unnamed mosquitoes during the year, and Mr. S. P. Agharkar of Bombay has described some Blepharoceridæ, mostly larvæ, recently collected in Kashmir by Mr. H. L. Bion of the Geological Survey of India.

Thysanoptera.—Mr. R. S. Bagnall of Oxford is still working on the Thrips we have sent him.

Aphaniptera.—Hon. Chas. Rothschild of London is again working on our fleas.

Hemiptera.—Mr. Rothschild has returned the Polyctenidæ we sent him. Mr. E. A. Andrews of the Indian Tea Association is working on the Pentatomidæ of the Abor Expedition. Dr. P. Van der Goot of Salaliga, Java, and Mr. W. L. Distant of London are still working on material sent to them. Our specimens of Tingidæ and *Octherus* are being sent to Dr. G. Horváth at Buda-Pesth."

Public Galleries.

The question of the re-arrangement of the zoological galleries has received much attention from myself, Mr. Kemp and Mr. Gravely, and the last has done a great deal to improve the entomological gallery, in which he has set up new or practically new exhibits illustrating biological problems such as variation, secondary sexual characters, etc.

In the other zoological galleries lack of funds still renders a complete re-arrangement impossible, but we are not without hope that something radical may be done next year in the invertebrate gallery. As a preliminary measure great improvements have been made in the lighting and ventilation by the Public Works Department, and these are probably better now than in any other gallery in the Museum. The cost of the alterations has been met from the contribution grant made by the Government of India in 1904 and augmented in 1906.

In the large mammal gallery several fresh specimens have been mounted, in particular a four-horned domestic sheep from Nepal remarkable for its resemblance to certain breeds found in the islands of northwestern Europe.

In the bird gallery the old specimens of eight common species have been replaced by fresh ones.

In the reptile gallery additional specimens of the edible turtle (presented by Mr. W. S. Adie, I.C.S.), and of the gharial (presented by Messrs. D. N. Biswas & Co.) have been set up.

As was explained in last year's report, the services of Mr. C. A. Paiva were again placed at the disposal of the Trustees and it was arranged that he should act primarily as assistant in the entomological laboratory, but should also conduct visitors round the zoological galleries at certain times. As a preliminary measure notices were placed in prominent positions at the entrance to the Museum stating that he would be permitted to do so on Fridays, if applications were made to the gate clerk. There has, however, been literally no demand for his services in this direction.

Field-work.

With the approval of the Trustees, it has been arranged that in future the field-work of the Zoological and Anthropological Section of the Indian Museum (until it is merged in that of the proposed Zoological Survey) shall be directed annually in the main either towards a definite area or a definite piece of research. Since the revival of this branch of work in connection with the Museum some eight years ago it has been necessary in the first place to render ourselves acquainted in a general way with the fauna of different districts as it exists in the field, but now that this preliminary work has been carried out it has become possible to regulate our investigations in a more scientific manner and to work along definite lines in so doing.

The first scheme organized under the new system is an intensive faunistic study of the Chilka Lake in Orissa and the Ganjam district of Madras, which offers peculiar facilities for the study of a brackish-water fauna. We have already accomplished a considerable amount of work in this direction and hope that, so far as the field-work is concerned, our task will be accomplished by the end of 1914.

Research.

A considerable part of the time devoted to research by Mr. Kemp and myself during the year has been connected directly or indirectly with our survey of the Chilka Lake.

Mr. Kemp has also brought to a conclusion his investigations of the anatomy of *Typhloperipatus williamsoni*, the Peripatus found by him in the foothills of the Eastern Himalayas during the Abor Expedition.

I have continued my own researches on freshwater sponges and in particular on those of tropical Africa, whence Dr. W. Michaelsen of Hamburg has sent me a valuable collection for study, and on those of the

Jordan system. In order to understand the origin and distribution of the Indian forms collections from both these regions must be examined with particular care.

Dr. B. L. Chaudhuri, who has recently received from the University of Edinburgh the degree of Doctor of Science for his ichthyological work in Calcutta, has continued his investigations into the freshwater fish of Northern India and has nearly completed a report on those of the Chilka Lake.

Mr. F. H. Gravely, since his return from study leave in Germany, has completed his monograph on the Passalid beetles of the Oriental Region, which will be published shortly. The great assistance given him by entomologists in Hamburg and Berlin, and more particularly by Herr Hans Gebien of the former city, must be acknowledged with due gratitude.

Mr. Brunetti still works, so far as his private engagements permit, at the Diptera in our collection; he has in hand for the "Fauna of British India" series a second volume on that group of insects and has nearly completed a catalogue of the Nematocera of the Oriental Region which should be of the greatest use to students of these flies.

Captain R. B. Seymour Sewell, Surgeon-Naturalist, Indian Marine Survey, has, while in Calcutta, continued his work on the Copepods of Indian Seas. On the "Investigator" he has introduced new types of nets which have proved useful in the capture of mid-water crustacea and other animals.

Mr. T. Southwell, Deputy Director of Fisheries, Bengal, has worked in our laboratory, whenever his strictly economical duties have permitted, on Indian Cestodes and Trematodes and has already published two papers in the "Records of the Indian Museum."

Major F. Wall, I.M.S., while on leave spent some weeks in the Indian Museum studying the collection of snakes, in which he was kind enough to identify all the unnamed specimens.

Lecture Scheme.

At the request of the Government of Bengal, acting at the suggestion of the Government of India, the Museum has agreed to organize in future two series of popular lectures annually, a general miscellaneous course in the cold weather and a slightly more technical one during the "rains." The first general course was delivered by officers attached to different sections of the Museum in November and December 1913 and January 1914. Two of the lectures were zoological, one on "The Freshwater Fishes of Bengal" (in Bengali) by Dr. B. L. Chaudhuri and one on "Sponges as Living Animals" by myself. The summer course this year has been given by Mr. T. H. Gravely and has dealt with the "Insects

and Spiders of Calcutta." Both courses have been well attended by the general public.

Proposed Zoological Survey of India.

Proposals, with which this Board has expressed itself as in general agreement, have been submitted by the Trustees of the Indian Museum to the Government of India for the recognition of a Zoological Survey similar in character to the Botanical Survey of India and based on the existing Zoological and Anthropological Section of the Indian Museum. The Government of India have expressed its approval of these proposals, which will shortly be submitted to the Secretary of State. As a misunderstanding has arisen among some private naturalists in India as to the scope and functions of the proposed Survey I take this opportunity to point out that, should it receive the sanction of the Secretary of State in its present form, the Trustees' scheme involves no interference of any kind with individual work or with that of private societies. The object of the proposal is merely to give the science of zoology an official position comparable to that which botany and geology already possess, and to place directly at the disposal of the Government of India the services of the zoological staff now employed by the Trustees in a somewhat indefinite status. At present there is no officer whose duty it is to maintain the interests of zoology and zoologists with the Imperial Government, and there is no zoologist whom Government can consult officially as to problems of a general zoological nature that may arise in India.

ANTHROPOMETRICAL WORK.

For some years past I have had in contemplation the institution of anthropometrical investigations on the people of Calcutta, but administrative and scientific duties connected with zoology have prevented this until within the last few months. I have now commenced, with the help of Messrs. Hodgart and Caunter, Zoological Collector and Gallery Assistant respectively, to measure a large series of Anglo-Indian men—to use the term Anglo-Indian in its official sense—with a view to ascertain (1) whether there is any greater variation in a race known to be of mixed origin than in many races of which the origin is unknown, and (2) whether measurements, accompanied by observations on colour, etc., throw any real light on the percentages or nature of racial admixture. So far, the work has been largely of an experimental nature, but over 100 individuals have been examined.

The Asiatic Society of Bengal is about to publish in its "Memoirs" the results of anthropometrical investigations made in the Abor country by Messrs. S. W. Kemp and J. Coggin Brown in the course of the expedition of 1911-1912.

List of Publications on Indian Zoology.

The following list of books, memoirs, etc., that have a direct bearing on Indian zoology and were published between the months of August 1913 and July 1914 has been drawn up as usual by Dr. B. L. Chaudhuri.

The list includes several lengthy and important works of a general nature, in particular Dr. E. H. Hankin's "Animal Flight," in which is included an account of many observations made in India, and "A Text Book of Medical Entomology" by Captain W. H. Patton and Captain F. W. Cragg of the Indian Medical Service; doubtless this work will be noticed more fully in the report on economic entomology.

Of faunistic work carried out and published in India the most comprehensive is Mr. S. W. Kemp's monograph on the Indo-Pacific Stomatopod Crustacea. Notice may also be directed to a volume on the Orthopterous family Acridiidæ written in London by the late Mr. W. F. Kirby and published in the "Fauna of British India," and to a series of short papers embodying investigations connected by the survey of the mammals of India which is now being undertaken by the Bombay Natural History Society. The scientific results of this survey are being worked out in London.

Five parts of the special volume of the "Records of the Indian Museum" which deals with the zoological results of the Abor Expedition of 1911-1912, have been published, including thirty-five papers by a number of authors of different nationalities, several of whom have carried out their investigations in this country.

Professor R. Koehler's account of the Spatangoid Sea-Urchins is the seventh part that he has contributed (in several instances in collaboration with his colleague in the University of Lyons, Professor C. Vaney) to the catalogue of the Echinoderma in the collection of the Indian Museum.

General.

Annandale, N. . . The African element in the Freshwater Fauna of British India. (*IX° Congr. Intern. Zool., 578.*)

,, ,, . . Catalogue of the Exhibition prepared in connection with the Centenary Celebrations of the Indian Museum Zoological Experts.

Annandale, N., & Gravely, F. H. The Fauna of the Limestone caves of Burma and the Malay Peninsula. (*Journ. Asi. Soc. Beng., ix, 329.*)

Fryer, F. C. F. . Field-observations on the Enemies of Butterflies in Ceylon. (*Proc. Zool. Soc. Lond., 1913, 613.*)

HANKIN, E. H. . . Animal Flight. A Record of Observation.

KEMP, S. W. . . Preliminary Note on the Zoological Results of the Abor Expedition on the North-East Frontier of Assam. (*IX° Congr. Intern. Zool., 595.*)

PATTON, W. S., & CRAGG, F. W. A Text Book of Medical Entomology.

SEWELL, R. B. S. . Notes on the Biological Work of the R. I. M. S. S. "Investigator" during Survey seasons 1910-11 and 1911-12. (*Journ. Asi. Soc. Beng., ix, 329.*)

PROTOZOA.

STEPHENS, J. W. W. A new Malaria Parasite of Man (*Plasmodium tenue*). (*Proc. Royl. Soc., Series B, lxxxviii, 375.*)

WOODCOCK, H. M. . Further remarks on the Flagellate Parasites of Culex. (*Zool. Anzeig., xlv, 26.*)

PORIFERA.

ANNANDALE, N. . . Notes on Freshwater Sponges, XV. (*Rec. Ind. Mus., ix, 237.*)

,, ,, . . Some Sponges commonly associated with Oysters and Mussels in Madras Harbour and the Chilka Lake. (*Ibid., x, 149.*)

CŒLENTERETA.

AGHARKAR, S. P. . Further Notes on the Habits and Distribution of *Limnocnida indica*. (*Rec. Ind. Mus., ix, 247.*)

MENON, K. R. . . Note on the Genus *Anactinia*. (*Ibid., x, 211.*)

,, ,, . . Preliminary Note on the Metamorphosis of *Zoanthella*. (*Ibid., x, 212.*)

ECHINODERMATA.

BOMFORD, T. L. . . A Note on certain Ophiuroids in the Indian Museum. (*Rec. Ind. Mus., ix, 219.*)

KOEHLER, D. R. . An Account of the Echinoidea of the Indian Museum. (*Echinoiderma of the Indian Museum, Part viii.*)

,, ,, . Change of name in an Indian Genus of Echinoidea. (*Rec. Ind. Mus., x, 213.*)

PEARSON, J. . . Notes on the Holothuroidia of the Indian Ocean. (*Spolia Zeylan., ix, 49 & 173.*)

,, ,, . . Proposed re-classification of the Genera *Mülleria* and *Holuthuria*. (*Ibid., 163.*)

VERMES.

GRAVELY, F. H. . Temnocephalidæ of the Abor Expedition. (*Rec. Ind. Mus., viii, 229.*)

PLATE, L. . . . Untersuchungen Zur Fauna Ceylons nach den sammlungen. Zwei Ceylonische Temnocephaliden: (1) *Caridinicola indica*, Annandale. (2) *Monodiscus parvus*, Plate, n. g., n. sp. (*Jenaisch. Zeit. Natur., li, 707.*)

SOUTHWELL, T. . . On some Indian Cestoda. (*Rec. Ind. Mus., ix, 279.*)

STEPHENSON, J. . . Oligochaeta of the Abor Expedition. (*Ibid., viii, 365.*)

STEWART, F. H. . Studies in Indian Helminthology. (*Ibid., x, 165.*)

,, ,, . The Anatomy of *Polystomum kachugae*, Stewart, with Notes on the Genus Polystomum. (*Ibid., x, 195.*)

WHITEHOUSE, R. H. . Freshwater Planaria of the Abor Expedition. (*Ibid., viii, 318.*)

CRUSTACEA.

ANNANDALE, N. . . The Indian Barnacles of the Sub-Genus *Scalpellum*. (*Rec. Ind. Mus., ix, 227.*)

COLLINGE, W. E. . On some new Terrestrial Isopods from the Andaman Islands and Southern India. (*Ibid., 207.*)

KEMP, S. W. . . An Account of the Crustacea Stomatopoda of the Indo-Pacific Region. (*Mem. Ind. Mus., iv, No. 1.*)

KEMP, S. W. . . Illustrations of the Zoology of the R. I. M. S. S. "Investigator." (*Ibid., No. 1.*)

,, ,, . . Decapoda of the Abor Expedition. (*Rec. Ind. Mus., viii, 289.*)

,, ,, . . Notes on Crustacea Decapoda in the Indian Museum. (*Ibid., x, 81.*)

PARISI, B. . . . Decapodi giapponesi del Museo di Milano. (*Att. del. Soc. Ital. Sci. Nat., liii, 5.*)

SEWELL, R. B. S. . Notes on the Surface Copepoda of the Gulf of Mannar. (*Spolia Zeylan., ix, 191.*)

,, ,, . . Notes on Plankton from the Chilka Lake. (*Ibid., ix, 338.*)

,, ,, . . Some Observations on the development of the Copepoda. (*IX^e Congr. Inter. Zool., 492.*)

TATTERSALL, W. M. . Amphipoda of the Abor Expedition. (*Rec. Ind. Mus., viii, 449.*)

,, ,, . Further records of Indian Brackish water Mysidæ with descriptions of a new genus and species. (*Ibid., x, 76.*)

ONYCHOPHORA.

KEMP, S. W. . . Preliminary Note on a New Genus of Onychophora from the North-East Frontier of India. (*Rec. Ind. Mus., ix, 241.*)

ARACHNOIDEA.

ELLINGSEN, E. . . On the Pseudo-Scorpeons of the Indian Museum. (*Rec. Ind. Mus., x, 1.*)

ROEWER, C. F. . . Opileones of the Abor Expedition. (*Rec. Ind. Mus., viii, 203.*)

INSECTA.

AGHARKAR, S. P. . On a New Species of Blepharocerid Fly from Kashmir with a description of some larvæ from the same locality. (*Rec. Ind. Mus., x, 159.*)

AIYAR, T. V. R. . On the Life-History of *Coptosoma cribraria*, Fabr. (*Journ. Bomb. Nat. Hist. Soc., xxii, 412.*)

AIYAR, T. V. R. . . Note on the Life-History of a Phasmid. (*Ibid., xxii, 641.*)

ANNANDALE, N. . . Adaptation in the habits of a Tabanid fly. (*Rec. Ind. Mus., iv, 245.*)

" " . . Indian Blood-sucking Midges. (*Ibid., ix, 246.*)

ARROW, G. J. . . On the Ceylonese Species of Ruteline Coleoptera belonging to the genus *Adoretus*. [*Ann. Mag. Nat. Hist., xiii (8th Ser.), 587.*]

" " . . On the Burmese Species of Rutetine Coleoptera belonging to the genus *Adoretus*. (*Ibid., xiii, 594.*)

" " . . Lamellicornia (Coleoptera) of the Abor Expedition. (*Rec. Ind. Mus., viii, 191.*)

ASSMUTH, J. . . Wood-destroying White Ants of the Bombay Presidency. (*Journ. Bomb. Nat. Hist., xxii, 372.*)

AVINOFF, A. . . Butterflies of the Genus *Parnassius* in the collection of the Indian Museum. (*Rec. Ind. Mus., ix, 327.*)

BAGNALL, R. S. . . Brief descriptions of new *Thysanoptera*. [*Ann. Mag. Nat. Hist., xii (8th Ser.), 290.*]

" " . . Thysanoptera of the Abor Expedition. (*Rec. Ind. Mus., viii, 191.*)

BANKS, N. . . Neuropteroid Insects of the Abor Expedition and from Tenasserim. (*Ibid., viii, 351.*)

BELL, T. R. . . The common Butterflies of the Plains of India. (*Journ. Bomb. Nat. Hist., xxii, 320 and 517, xxiii, 73.*)

BRUNETTI, E. . . New and interesting Diptera from the Eastern Himalayas. (*Rec. Ind. Mus., ix, 255.*)

" " . . Diptera of the Abor Expedition. (*Ibid., viii, 149.*)

" " . . Critical Review of Genera in *Culicidae*. (*Ibid., x, 15.*)

BUGNION, E. . . L'imago de *l'Eutermes lacustris* de Ceylon. (*Spolia Zelan., ix, 149.*)

" " . . *Eutermes hantanae* de Ceylon. (*Ibid., 155.*)

" " . . Le *Termitogeton umbilicatus*, Hag. de Ceylon. (*Ann. Soc. Entom., lxxxiii, 39.*)

CAMERON, M. . . Description of New Species of Staphylinidae from India. (*Trans. Entom. Soc. Lond., 1913, 525.*)

COLEMAN, L. C. . . New Species of Indian Grasshoppers. (*Journ. Bomb. Nat. Hist. Soc., xxiii, 172.*)

CRAGG, F. W. . . The Comparative Anatomy of the proboscis in the Blood-sucking Muscidæ. [*Scien. Memr. Offic. Med. Sanit. Depart. Gov. Ind., No. 60 (New Series).*]

DISTANT, W. L. . . Contributions to a knowledge of Oriental Rhynchota. [*Ann. Mag. Nat. Hist., xii (8th Ser.), 283.*]

,, ,, . . Some additions to the genera and species in Homopterous Family Fulgoridae. [*Ibid., xiii (8th Ser.), 409.*]

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ZOOLOGY.

II.—ECONOMIC ZOOLOGY.

Part I.—Agricultural Entomology.

BY

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I.—Work at Pusa.

General work.—Investigation into the life-histories of injurious and other insects was continued, the following insects being those of which at least complete life-cycles were obtained:—

Pyrilla aberrans, *Aleurodes bergi* and *A. citri*, *Atractomorpha crenulata*, *Eublemma olivacea*, *Odoiporus longicollis*, *Virachola isocrates*, an unidentified Dermestid beetle on Stored Wheat, *Harpactor costalis*, *Canthecona furcellata*, *Syntomis cyssea*, *Taragama siva*, *Polyocha saccharella*, *Dolycoris indicus*, a Psocid on *Loranthus*.

Figures of the various stages of most of these insects have been drawn and will be utilized for Memoirs on the insects concerned.

The subject of natural enemies (parasites and predators) of crop-pests is of great importance in India and a start is being made to collect information on the subject. Special attention has been paid to the parasites and hyperparasites of Cotton Bollworms (*Earias* spp.), of *Achæa melicerta* and of *Pieris brassicæ*. Parcels of *Earias* larvæ parasitized by *Rhogas lefroyi* were sent to the North-West Frontier Province and the Punjab to endeavour to assist control of this pest. There is no doubt that in the near future such control-methods will be found to be applicable in many cases, especially in the case of introduced pests, and we are already receiving numerous inquiries from abroad (notably America and Italy) regarding parasites of destructive crop-pests, and an attempt is being made to procure a parasitized colony of *Aleurodes citri* for export to Florida where this insect has done vast damage to the orange industry. In this connection it is of interest to note that an apparently identical parasite has also been reared from *Aleurodes ricini*, which occurs commonly on Castor in India, and specimens of the two parasites have been sent to Washington for exact determination, as their identity, if established, will be of practical importance.

Attempts have been made to trace *Agrotis ypsilon* through the hot weather and rains, as it is not known in what stage the insect passes this period on the Mokameh Tal, if it is actually present then at all. Incidentally, in collecting the larvæ it was found that they are preyed upon extensively by a Carabid beetle (*Broscus punctatus*).

The study of insects affecting stored grain was continued by the Supernumerary Entomologist, and the life-histories of *Æthriostoma undulata*, *Tribolium castaneum* (*ferrugineum*) and *Rhizopertha dominica* have also been worked out by Mr. Nowroji.

Special attention has also been paid to the insect pests of paddy and sugarcane, and large numbers of insects have been bred out and their study will be taken up when sufficiently long series are secured both from Pusa and the provinces. It may be noted here that paddy stubble, collected in the fields at Pusa in February, showed that about forty per cent. of the stalks contained borers.

Work on termites has been continued and determinations of upwards of four hundred lots of these insects were received from Professor Nils Holmgren, of Stockholm; the identification of this material not only increases by some twenty species the list of known Indian forms, but will prove of great assistance in the discrimination of the various kinds found to do damage and in the writing up of a large accumulation of notes on their bionomies and occurrence. Wood treated by various processes was examined in February 1914 and some of the pieces of powellized wood were found to be attacked by *Microtermes obesi* (*anandi*); this process is therefore not so infallible as has been claïmed. Examination of some of the other series indicated that exemption from attack depends on the variety of the wood itself as well as on the method of treatment and in addition to the preferential tastes shown by the various species of termites locally prevalent; this point scarcely seems to have received proper consideration hitherto and it is proposed to initiate further series of experiments.

The green scale, *Coccus viridis* (*Lecanium viride*), which has proved such a serious pest of coffee in Ceylon and Southern India, first invaded Coorg in 1913 and bids fair to become a serious pest there also. In May 1914 I visited Coorg, saw the affected areas and advised the planters on the subject. The scale was found to be parasitized to a very slight extent by a minute Chalcidid, apparently a species of *Coccophagus*, which has been sent to Washington for exact determination.

A consignment of *Microsporidium polyhedricum* in dead silkworms was received from the Government Entomologist, Egypt. This organism is said to be effective in the control of *Prodenia litura* in Egypt, but experiments at Pusa, conducted with the help of the Imperial Agricultural Bacteriologist, gave negative results with silkworms and larvæ of *Prodenia litura*.

Silk-work.—A multivoltine mongrel race of mulberry silkworms was established after many trials, and this at first yielded silk superior in quality and quantity to those of the Bengal multivoltine races, but this strain unfortunately began to deteriorate after the fourteenth generation and in the sixteenth generation there was practically no difference between the mongrel race and the ordinary Bengal multivoltine races. Experiments are being continued to try and obtain a stable race. The univoltine mulberry silkworm eggs which were sent for cold storage to Ramgarh (Naini Tal), Muktesar and Calcutta, gave satisfactory results. Six students completed short courses in Eri and Mulberry Silkworm rearing during the year.

Lac-work.—During the two lac seasons (October and June) at Pusa, upwards of 200 ber trees were inoculated and the crop scraped, washed and sold. There were no students for either course and this is doubtless due to the fact that practical instructions have been given in the Bulletin on " The Cultivation of Lac in the Plains of India," of which the first edition of 1,500 copies was soon exhausted and a second revised edition was prepared and issued during the year; a Hindi edition is now in the press and an Urdu edition is in preparation. Brood-lac was supplied to twelve applicants and answers were sent by correspondence to numerous inquirers in various parts of India. The Superintendent of Industries in Banganapalle State spent a week at Pusa picking up details of the lac-work and was subsequently supplied with seed to commence work on an experimental scale. The services of Mr. C. S. Misra were also requisitioned by the Karauli State to start and supervise lac-culture in that State; he obtained kusumb brood-lac from Rewah, selected the localities in Karauli where work was to be commenced and started inoculation of the trees selected. After doing this Mr. Misra visited Sind to obtain babul brood-lac and to study the methods of propagation practised in that District. Collection of lac specimens by the Forest Officers continued throughout the year, the series being, however, now completed for some districts.

Apiculture.—At Pusa the last of the imported Italian queens died in July 1913. At that time there were two colonies headed by queens reared at Pusa and in August a third queen was reared and fertilized, but in the course of the year all the three queens failed and the bees died out. The proper fertilization of the queens seems to be at present the main difficulty in establishing these bees in the plains; the workers seem to do well and it is comparatively easy to rear new queens as required, but these are usually snapped up by insectivorous birds during their marriage-flight or, if they survive this, fertilization does not seem to have been sufficiently thorough, as after a few months they commence to produce drone-brood only. Experiments have been continued with the Indian bee (*Apis indica*) and a mill for preparing foundation-wax for this bee has been procured, as have also queen-excluders of special size,

so that these bees can now be kept in bar-frame hives under modern conditions. A Bulletin on bee-keeping has been prepared and submitted for publication. As Apiculture in the plains is still in an experimental stage, no regular course of instruction in bee-keeping can be given, but entomological students and interested visitors have been given such information as they required.

Insect Survey.—The collections continue in good order and numerous additions have been made by specimens collected during tours and those sent in by correspondents. Neuroptera were received back named from Mr. N. Banks, Ichneumonidæ from Mr. Morley, and Orthoptera named by the late W. F. Kirby. The Chalcididæ have been sent to Dr. L. O. Howard, of Washington, who has kindly consented to have them determined, and the Rutelidæ to Mr. G. Arrow for his "Fauna" volume on this group. The whole of the collections will be placed in one series, in order that the whole of the information available concerning any one species may be available in one place, and this work has been commenced.

II.—Work in the Provinces.

All the provinces have now a trained staff comprising one or more Entomological Assistants, Madras being the only province with its own Entomologist.

In Madras the Deccan grass-hopper work was continued in the Bellary District, but the failure of the rains at the commencement of the monsoon caused the destruction by drought of the early-sown crops in the area attacked so that the control-operations proved abortive on this account. The Entomological Laboratory fittings and the Insectary at Coimbatore were completed during the year and the collection re-arranged in the new boxes. A large amount of information on insect pests was amassed and much of this was utilised for a book on South Indian insects which was written and completed by himself before leaving Madras. My successor, Mr. E. Ballard, who had been Government Entomologist in Nyasaland for the preceding two years, joined his new appointment at Coimbatore in January 1914 and has since been engaged in familiarising himself with the insects of the Madras Presidency. In Madras a fieldman has been employed on special duty on Sericulture in the Kollegal District; he has given practical instruction to the mulberry-silkworm rearers and a short vernacular leaflet with practical instructions for rearing has been prepared.

In Bombay there are now only two Entomological Assistants employed, one as Lecturer in the Agricultural College at Poona, the other in the Northern Division of the Presidency. The third assistant, who was

stationed at Dharwar in the Southern Division, has been transferred to the Agricultural Section and his post has not been filled. Special attention has been paid to the occurrence and control of *Schoenobius bipunctifer*, which is a serious pest of rice.

In the Central Provinces two Entomological Assistants are employed, one for teaching at the Agricultural College at Nagpur, the other for fieldwork and demonstration. The latter made numerous notes on insect pests and exhibited show-cases and lectured and demonstrated control-methods at numerous agricultural shows to audiences aggregating about nine thousand cultivators. Large numbers of *Canthecona furcellata*, a Pentatomid Bug predaceous on caterpillars, were bred and liberated in cotton and gram fields to check attacks on these crops by caterpillars. A little work on silk has also been done; some univoltine Mulberry silkworm eggs, received from Italy in October 1913, began to hatch in December and the worms which were reared from January to April, throve well and the resultant eggs have been kept in cold storage for the next season.

In the United Provinces, demonstration was made in the Farrukhabad District of methods of storing seed potatoes to avoid attack of the potato moth (*Phthorimæa operculella*) which is now widely distributed in these provinces though as yet it has apparently not reached the Hill Districts. In those provinces also Mr. Akhtar Mohammad Khan has remained on special duty in connection with the introduction of eri silk.

In the Punjab the work done has mainly been on pests of cotton and stored grain. Living specimens of *Rhogas*, a Braconid parasite ot the cotton bollworm (*Earias*), have been supplied from time to time from Pusa.

In the North-West Frontier Province one Entomological Assistant works under the Agricultural Officer. The sugarcane crop is reported as badly infested with borers this year, over 50,000 egg-clusters having been picked from one experimental plot of six acres. *Gelechia gossypiella* is stated to have done considerable damage to last year's cotton crop, but it is observable that late-ripening varieties were attacked most severely, local cotton (*Gossypium neglectum*), which ripens and is picked before the middle of October, practically escaping attack. Living specimens of *Rhogas* were supplied from Pusa and set free in the cotton-fields of the Agricultural Station at Tarnab, but it is doubtful whether they have established themselves. A Jassid Bug, attacking grape-vines in the vineyards situated in the lower parts of the Peshawar Valley, has also been under investigation.

In Bihar the entomological work has always been done in close touch with Pusa and this has been the result of policy rather than of the contiguity of the two localities. An account of the more

important pests was prepared some three years ago and was issued at the close of the year under review as a Crop-pest Handbook. The most important work undertaken has been the control of *Agrotis ypsilon* on the Mokameh Tal and the storage of potatoes. At Mokameh a regular campaign was undertaken and during the season 39,000 caterpillars were picked and destroyed on the high lands, whilst 34 traps destroyed 893,320 moths of which about 41 per cent. were females. On account of abnormal flood conditions and other factors, the attack was unusually serious, some 5,000 bighas of *rabi* pulse crops being destroyed. A similar campaign was undertaken against the same insect for the first time at Colgong and Ghogha, where 21 traps destroyed 43,874 moths whilst 337,600 caterpillars were handpicked from the high lands which were first attacked; the attack, which normally extends over an area of 8,000 bighas, was reduced to a nominal damage over about 20 bighas as a result of the above-mentioned efforts. The storage of seed potatoes has of late years presented great difficulties in Bihar, as in other provinces, as a result of the introduction into India of the potato moth (*Phthorimæa operculella*). Storage under dry sand has proved fairly effective in the districts south of the Ganges and Government godowns were started at Bihar, Bhagalpur, Colgong and Sabour in order to demonstrate the practicability and advantages of this method. Storage was done satisfactorily in all these places and the method of storage is becoming popular amongst the cultivators and others interested. That this method is actually being adopted is shown by the fact that at Patna and Bihar in 1913 no fewer than 1,520 persons stored 122,285 maunds of potatoes under sand, as compared with 16,613 maunds stored by 399 persons in 1912, and 8,000 maunds by 200 men in 1911. Another pest of stored potatoes in Tirhut is a Tingidid Bug (*Recaredus* sp.) and experiments are being made to find a successful method of control, as sand storage is found to induce rotting of the potatoes in the damp climate of Tirhut. In Bihar, the rearing of eri silkworms at Sabour was more successful during the year under report than in the previous season; eggs were distributed to a large number of Zamindars and cultivators in the Bhagalpur District, but the usual difficulty was found regarding the disposal of cocoons by the rearers on a small scale.

In Bengal, the entomological staff only includes one collector who is employed under the Government Botanist. He was chiefly occupied in dealing with pests of rice and also attended the agricultural shows at Barasat, Khulna, Suri, Brahmanbaria and Kamarchar, where he explained insect-pests and their life-histories and demonstrated the use of control methods.

In Assam the Entomological Assistant only went to his province in November 1913 on completion of his course of training at Pusa and his work has therefore only commenced. Rai Bahadur B. C. Basu was

placed on special duty during the year for the investigation of the possibilities of the local industry.

In Burma there is one Entomological Assistant, who was chiefly employed on the collection of information regarding insect-pests of rice.

III.—Work in Native States.

In Mysore the entomological work carried out during the year had to do chiefly with the investigation of *Amsecta albistriga*, Wlk., and *Coccus viridis* (*Lecanium viride*), the green scale of coffee which was first noticed in Mysore in 1913 and is spreading rapidly throughout the coffee districts.

In Travancore the Entomological Assistant first took up his work in October 1913 on completion of his course of training at Pusa and has since been employed especially on work in connection with the common crop-pests of Travancore.

In Baroda the Entomological Assistant gave demonstrations in the control of cotton bollworm (*Earias*) and Tobacco Stem-borer (*Gnorimoschema heliopa*) and other insect-pests of crops. Some experiments with lac on babul were also tried successfully.

In Kashmir no independent entomological work was done, but various pests of cotton and other crops were sent in to Pusa for information and advice which was given as required.

IV.—Other Work.

The Indian Tea Association employs an Entomologist, Mr. E. A. Andrews, the greater part of whose time during the first six months of the year was occupied in touring. The same period saw the completion of the work of fitting up the laboratory. The bulk of his time has been spent on the investigation of the tea Mosquito (*Helopeltis theivora*) and this investigation has led to the discovery of interesting relationships between the nature of the soil and the prevalence or otherwise of this pest. Extensive experiments are being carried out to discover a means of utilizing the knowledge of these relationships for checking this insect. Experiments on fumigating for termites and on spraying for red spider have been carried out. The systematic rearing of tea-pests with a view to the discovery of parasites has been carried on as usual, but this year the results have been somewhat disappointing. A very gratifying feature of the last twelve months has been the large number of applications from planters for advice as to treatment of insect-pests.

In Southern India also Mr. Anstead, the Planting Expert, has carried out observations on the pests of tea, coffee, rubber and other products.

Part II.—Forest Entomology.

BY

C. F. C. BEESON, B.A., I.F.S.,

Forest Zoologist.

Insects of the sal.—(*a*) The *sál* longicorns *Æolesthes holosericea* and *Hoplocerambyx spinicornis* were kept under observation in Bengal and the United Provinces. The appearance of the two species is identical in the larval stages, and the feeding habits are similar. While it does not appear possible to assign the annual damage locally to either species, it seems probable that *spinicornis* is the more dangerous pest.

(*b*) The life-history of a new platypodid, *Diapus furtivus*, Samps.,* has been worked out in Bengal, where it is intimately connected with the dying off of *sál* of all ages. Control measures will be attempted during 1914.

(*c*) The *sál* seedling moth-borer, *Pammene theristis*, Meyr., has been found throughout the United Provinces. It appears to be responsible for the death of 30 per cent. of seedlings annually.

(*d*) The following Ipidæ and Platypodidæ were found to be common *sál* borers in Bengal and the United Provinces; some are recorded from India for the first time:—*Xyleborus Andrewesi*, Bldfd. *X. laticollis*, Bldfd. *X. parvulus*, Eichh. *X. perforans*, Woll. *X. semigranosus*, Bldfd. *X. submarginatus*, Bldfd. *Diapus furtivus*, Samps. *D. quinquespinatus*, Chap. *Platypus curtus*, Chap. *P. solidus*, Chap.

(*e*) An outbreak of the defoliator *Ingura subapicalis*, Walk., occurred very generally in the United Provinces and Central Provinces *sál* areas. Damage was reported by the Divisional Officers, Haldwani, Gorakhpur, and Balaghat. A species of *Dasychira* was reported to be defoliating in Goalpara Division.

(*f*) In Mandla Division *sál* saplings were attacked by the bark-eating caterpillar *Arbela tetraonis*, Moore.

Insects of the teak.—(*a*) An enquiry into the seasonal history and distribution of the bee-hole borer of teak, *Duomitus ceramicus*, Walk., was commenced in Burma during the year. It was found that the existing account of the life cycle is not applicable throughout Burma, as the dates of the stages vary with the locality. It is hoped that it will be possible to establish experimental areas in Burma in

* In *Annals and Magazine Natural History*, Vol. 12, 1913, p. 450—452, Colonel Winn Sampson described two new species, *Diapus furtivus* ♂ ♀ and *Diapus mirus*. The field-work carried out in Bengal indicates that the sexes of *Diapus furtivus* should be reversed, and that *Diapus mirus* is a synonym = *Diapus furtivus* ♀.—C. F. C. B.

which the factors influencing the annual abundance of the pest can be determined, and in which control measures can be tested.

(*b*) Bee-holes, *i.e.*, cavities in the heartwood, are produced in poles and saplings by the following insects:—

Two hepialid moths, one species near to *Phassus malabaricum* (report also from Madras), three species of longicorn beetles and a chrysomelid bettle, *Sagra*, sp. The species of *Phassus* and one of the longicorns are as important economically in young woods as *Duomitus ceramicus*.

(*c*) Teak boring Ipidæ reported during the year and in 1912 are identified as *Xyleborus fraternus*, Bldfd., from Thaungyin and Katha Divisions, and *Xyleborus velatus*, Stamps., from Thaungyin and Tharrawaddy Divisions.

(*d*) A weevil *Alicides*, sp., was reported from Ruby Mines Division to be damaging young saplings.

Insects of the Toon.—The life-history of the toon shoot borer, *Hypsypyla robusta*, Moore, has been under investigation throughout the year in Dehra. Remedies for the control of the pest in both generations in avenues and plantations have been devised for the ensuing season.

Insects of the Chir.—(*a*) The bark beetle attacks in the Chir pine regeneration areas in Chakrata Division in 1912-13 and in Naini Tal Division in 1914 were due chiefly to *Tomicus longifolia*, Steb. This habit would appear to be a new one for the species, as it has not been known previously to attack and kill young pine growth. The remedial measures carried out in Chakrata were successful.

(*b*) The enquiry into the biology of the scale insect *Ripersia*, sp., was continued in Naini Tal Division. The pest is subject to a high degree of parasitism which would appear to be utilisable in control measures.

Miscellaneous pests.—(*a*) From the Sunderbans Division, Platypodidæ were reported to be attacking *Sundri*. The beetle is a species of *Crossotarsus* near to *Squamulatus*, Chapuis.

(*b*) In Jhansi Division, growing shoots of *Dendrocalamus strictus* were attacked by a trypetid fly near to *Stictaspis ceratina*, and by a bostrichid beetle *Bostrichopsis*, sp.

(*c*) In Siwalik Division, two species of Trypetidæ, *Chaetellipsis paradoxa*, Bezzi, and *Poecillis judicauda*, Bezzi, were bred from growing shoots of *Bambusa birmanica*.

(*d*) In Dehra Dun, the Pyralid moth *Glyphodes laticostalis* was found defoliating *Holarrhena antidysenterica*.

(*e*) In Cochin State a large weevil *Sipalus hypocrita*, Boh., was found breeding in *Bombax malabaricum*.

(*f*) From Jhansi Division the bostrichid *Sinoxylon anale*, Les., was reported to be killing off green Shisham saplings.

(*g*) The Ipidæ found boring into Padouk in the Andamans in 1912 have been identified as *Progenius laeviusculus*, Bldfd., *Progenius bidentatus*, Motsch., and *Xyleborus adumbratus*, Bldfd.

(*h*) Damage by Cockchafer grubs to Deodar seedlings was reported from Naini Tal and Kulu Divisions and *sál* seedlings from Gorakhpur Division.

(*i*) Specimens of a lasiocampid larva were sent by the Conservator of Forests, Assam, as defoliator of *Pinus Khasya* in the Khasia and Jaintia Hills.

(*j*) The Pentatomid bug *Ochrophora montana*, Dist., was reported to attack the seeds of *Bambusa Tulda* in Prome Division.

(*k*) Cossid larvæ were collected by Mr. Benskin in *Boswellia serrata* and *Anogeissus latifolia* in the Central Provinces, boring into the heartwood and producing a flow of gum.

List of Publications on Economic Zoology.

ASSMUTH, S. . . Wood destroying white ants of Bombay Presidency. (*Journ., Bomb. Natl. Hist. Soc., XXII, p. 372.*)

BAINBRIGGE FLETCHER, T. Note on Insects attacking the Paddy Plant. (*Bull. No. 67, Dept. of Agri., Madras.*)

BAINBRIGGE FLETCHER, T. List of Insect Pests of Cultivated Plants in Southern India. (*Note No. 1 of 1913, Dept. of Agri., Madras.*)

BURT, B. C. . . Note on Potato-moth in the United Provinces. (*Journ., Dept. of Agri., India,* January *1914.*)

CHATTERJEE, N. C. . Note on *Oxyrachys tarandus*, Fabr. (*Indian Forester, XL, February 1914, p. 75—79.*)

CLEGHORN, J. . . Melon Culture in Peshin, Baluchistan, and some accounts of the Melon Fly-Pest. (*Journ., Dept. of Agri., India, April 1914.*)

DE, M. N. . . Instructions for rearing Mulberry Silk-worms. (*Bull. No. 39.*)

DUTT, H. L. . . A new Insect Pest of Stored Potatoes. (*Journ., Dept. of Agri., Bihar and Orissa.*)

Dutt, H. L., & Basu, S. K. Crop-Pest Handbook. (*Journ., Dept. of Agri., Bihar and Orissa.*)

Ghosh, C. C. . . Life-Histories of Butterflies. (*Mem. Ento.*)

Grove, A. J. . . Some experiments with Maize stored in Bins. (*Journ., Dept. of Agri., India, January, 1914.*)

Holmgren, Nils . Termites from British India. (*Journ., Bomb. Natl. Hist. Soc., XXII, p. 101.*)

Kanehira, R. . . Some timbers which resist the attack of termites. (*Indian Forester, XI, January 1914, p. 23—42.*)

Khamparia, R. . . Leaflets (in Hindi) on Insect Pests of Cotton and Juar, Gram-pod Borer, and on Sugarcane Borer. (*Dept. of Agri., Central Provinces.*)

Misra, C. S. . . The Cultivation of Lac. (*Bull. No. 28, 2nd edition.*)

,, ,, . Red spider on Jute. (*Journ., Dept. of Agri., India, October 1913.*)

Savage, R. E. . . The Respiratory System of *Monophlebus* Stebbing var. *octocaudata*. (*Bull. Entomological Research, Vol. V, Pt. 1, April 1914, p. 45—47.*)

Sen, P. C. . . Dhan'er Poka (A Bengali pamphlet on Insect Pests of Rice). (*Dept. of Agri., Bengal.*)

,, ,, . . Insect Pests and general measures for prevention and remedy. (*Dept. of Agri., Bengal, Leaflet No. 3, 1913.*)

Witt, D. O. . . Notes on life-history of *Cyrtotrachelus longipes*, Fabr. (*Indian Forester, XXXIX, June 1913, p. 265—272.*)

Woodhouse, E. J., & Dutt, H. L. Further Work against Surface Caterpillars at Mokameh in 1912. (*Journ. Agri. India, October 1913.*)

Woodhouse, E. J., & Dutt, H. L. Surface Caterpillar on Mokameh Tal, Third Report, 1912-13. (*Journ., Dept. of Agri., Bihar and Orissa, Vol. I, No. 2.*)

Woodhouse, E. J., & Dutt, H. L. Potato storage work in Bihar and Orissa, Third Report. (*Journ., Dept. of Agri., Bihar and Orissa.*)

,, ,, . . Eri Silk. (*Bull No. 29, 2nd edition.*)

VETERINARY SCIENCE.

BY

MAJOR J. D. E. HOLMES, C.I.E., M.A., D.Sc.,
Imperial Bacteriologist, Muktesar.

The following is a review of the Research work carried out during the year 1913-14 in the Imperial Bacteriological Laboratory, Muktesar:—

Rinderpest.—The experiments as regards the influence of various drugs on the course of rinderpest were completed and the results submitted for publication.

Some experiments were made on the effect of heat on the rinderpest immune bodies, and a paper on this subject submitted for publication.

Surra.—Further experiments on the treatment and transmission of Surra were carried out.

A further attempt was made to carry out an investigation on certain questions connected with the transmission of Surra by means of biting flies on the Kathgodam-Ranikhet Road.

Mr. Meadows, Assistant Bacteriologist, and Mr. Mitter from Pusa worked on this subject from the middle of August to the end of September 1913, but did not obtain any results owing to the difficulty in keeping biting flies alive in captivity.

Anthrax.—An investigation was made on the immunising effect of the simultaneous injection of Anthrax attenuated virus and an Anthrax anti-serum; a paper on this subject has recently been submitted for publication.

Many other experiments were made on the preparation of dead vaccine.

Hæmorrhagic Septicæmia.—Experiments were made on the drug treatment of Hæmorrhagic Septicæmia in cattle and the results submitted for publication.

The investigation on the vitality of the Hæmorrhagic Septicæmia organism outside the body was concluded and a paper on the subject has been published.

Kumri.—The investigation on the etiology of Kumri was continued, but no definite results have been arrived at.

Bursati.—The investigation on the etiology and treatment of Bursati was continued and the result submitted for publication.

A list of Papers published during 1913-14 bearing on Indian diseases.

GAIGER, S. H. . Glanders in Man. (*Journ. of Comp. Patho. & Thera., Vol. XXVI, p. 223.*)

HILLARD, J. J. . Treatment of Canker of the foot of the Horse by the internal administration of arsenious acid. (*Vety. Record, Vol. XXVI, p. 314.*)

HOLMES, J. D. E. . The Curative Treatment of Hæmorrhagic Septicæmia in Cattle by the Administration of Iodine. (*Vety. Journ., Vol. 70, No. 268, p. 277.*)

" " . A Note on some Interesting Results following the internal administration of Arsenic in Canker and other Diseases of the Foot in Horses. (*Vety. Journ., Vol. 69, p. 259.*)

" " . Further Investigations on questions connected with the economical production of Anti-serum (Rinderpest). (*Memoir of the Dept. of Agri., Vety. Ser., Vol. II, No. 2.*)

" " . The Curative Treatment of Hæmorrhagic Septicæmia in cattle by the administration of Iodine and other notes on Chemiotherapy in Rinderpest and Hæmorrhagic Septicæmia. (*Memoir of the Dept. of Agri., Vety. Ser., Vol. II, No. 3.*)

" " . The Vitality of the Hæmorrhagic Septicæmia Organism outside the body. (*Memoir of the Dept. of Agri., Vety. Ser., Vol. II, No. 4.*)

" " . Memoir on "Bursati." (*Memoir of the Dept. of Agri., Vety. Ser., Vol. II, No. 5.*)

" " . A note on the effect of heat on the Rinderpest immune bodies. (*Agri. Bull. No.* .)

HOWARD, G. G. . Anthrax in Elephants. (*Vety. Record, Vol. XXVI, No. 1308, p. 69.*)

KELLY, L. J. . Canine Distemper. (*Vety. Record, Vol. XXVI, p. 138.*)

MITTER, S. N. . *Strongylus Clathurtus*, Braid. (*Vety. Journ., Vol. 69, p. 257.*)

OLIVER, E. W. . Note on Glanders. (*Bull. No. 31 of Dept. of L. R. & A., United Provinces.*)

" " . Note on Rinderpest. (*Bull. No. 28 of Dept. of L. R. & A., United Provinces.*)

TURNER, G. . . The Production of Immunity to Rinderpest. (*Vety. News, Vol. X, p. 467.*)

WALKER, G. K. . The Treatment of Rinderpest and Hæmorrhagic Septicæmia with permanganate of Potash. (*Journ. of Comp. Patho. & Thera., Vol. XXV, Part 3, p. 185.*)

,, ,, . The Arsenical Treatment of Surra in Horses. Record of four cases. (*Journ. of Comp. Patho. & Thera., Vol. XXVII, p. 71.*)

,, ,, . Pleuro-Pneumonia of Goats in the Kangra District, Punjab. (*Journ. of Comp. Patho. & Thera., Vol. XXVII, p. 68.*)

VALLADARES, J. F. . Equine Biliary Fever in Madras. (*Parasitology, Vol. VII, No. 1, p. 88.*)

APPENDIX.

Report on the Scientific and Technical Investigations conducted for India at the Imperial Institute during the year ended 30th June 1914.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.,
Director, Imperial Institute.

The scientific and technical investigations which have been carried out at the Imperial Institute for India during the year ended 30th June 1914 are as follows:—

Cotton.—Twenty samples of cotton from the Punjab, representing varieties which have been grown at the Government Experimental Farm at Lyallpur for the last five years, were all of fair quality and would be saleable in the United Kingdom. They were valued in Liverpool at prices ranging from $5\frac{7}{8}d.$ to $6\frac{3}{4}d.$ per lb. with "middling" American at 6·69*d.* per lb.

Seven samples of American cotton, submitted by the Deputy Director of Agriculture in Sind, were of very satisfactory quality and would be readily saleable at Liverpool; they were valued at prices ranging from 7·10*d.* to 8·20*d.* per lb. with "middling American" at 6·96*d.* and "fully good middling American" at 7·25d. per lb.

Thirteen samples of cotton, grown on the Government Experimental Farm at Akola, Central Provinces, were clean and of very satisfactory quality. Most of them were too short, coarse and rough to be readily saleable in Liverpool, but three of the specimens (Bani III and Buri I and II) were of a quality for which there is generally a good demand.

Fibres.—Small consignments of *Sida* and *Urena lobata* fibres prepared experimentally by the Government Fibre Expert at Dacca, were sold by the Imperial Institute in London during the year. The fibres were fine, lustrous, and of very good quality. The two consignments were sold together as one lot at £36 per ton, when "first native marks Calcutta jute" was quoted at £35 10*s.* to £36 per ton. The merchants who disposed of the consignments stated that the fibres were the nearest substitute for Bengal jute that had ever come into the market, adding that the spinners who purchased them were most anxious to obtain further supplies from India. They expressed the opinion that these fibres, if of equal quality to the present samples, would ultimately bring a higher price than "first marks" jute. Commercial

enquiries since received at the Imperial Institute show that considerable interest is being taken in these two Indian fibres.

Rubber.—A sample of *Cryptostegia grandiflora* bark from the Punjab yielded only 2·0 per cent. of crude dry rubber and 1·37 per cent. of caoutchouc. If this is a normal amount it would appear that the quantity of rubber present in the bark is too small to make its extraction remunerative. A sample of small Cryptostegia stems was also examined, and found to contain only 0·43 per cent. of caoutchouc.

Two small samples of Castilloa rubber from the Bassein Agricultural Station, Bombay Presidency, were examined. One sample was of good quality and was valued at from 2*s*. to 2*s*. 3*d*. per lb. in London, with fine hard Para at 3*s*. 10*d*. per lb. and fine plantation Para 2*s*. 9*d*. to 2*s*. 10*d*. per lb.; the second sample, though similiar in appearance to the first, was rather soft and deficient in strength, and was considered not to be worth more than 1*s*. 6*d*. to 1*s*. 9*d*. per lb.

Food-stuff and fodders.—Thirty-one samples of barley from the Punjab, obtained by the Economic Botanist at Lyallpur in the course of his work on the improvement of barley, were examined at the Imperial Institute in order to determine their suitability and value for malting purposes. Information on the subject of Indian barley, with special reference to the use of the grain for malting purposes, was furnished to the Director-General of Commercial Intelligence at Calcutta.

A sample of Madagascar beans, grown at Natywagon near Mandalay under the supervision of the Department of Agriculture from seed supplied by the Imperial Institute, was submitted for examination. It had been suggested by the Imperial Institute that if this variety of beans could be successfully grown in Burma they would be much more remunerative to the producers than the ordinary Burma beans of commerce. The sample was of good quality and it was stated by merchants that if the standard were maintained the beans would realise the ordinary price of Madagascar beans in London, which was £23 per ton at the time. A sample of Victoria peas grown experimentally under the same conditions was of good quality and worth from £8 to £10 per ton in London. A number of samples of native beans from Burma, representing the results of selection experiments, were also examined in order to determine the amount of prussic acid which they yielded, and further experiments were recommended with a view to the isolation of pure races of the beans.

Information regarding the manufacture and use of compressed fodder in various countries was furnished during the year to the Director of Agriculture, Bombay.

Twenty-three samples of maize, representing the best varieties marketed in the United Kingdom, were supplied to the Director of Agriculture at Mandalay for experimental sowing in Burma.

Tobacco.—A sample of tobacco grown at the Nadiad Government Farm, Bombay, appeared to have been well grown and prepared, but on account of its bad burning qualities it would not meet with a ready sale in the United Kingdom. Such material could only be used for blending with other tobaccos in the manufacture of cheap smoking mixtures, and for this purpose it would only realise a very low price.

Essential oils.—In continuation of a previous enquiry on Cochin lemon-grass oil, two samples of the oil, stated to have been distilled from the red-stemmed and the white-stemmed varieties of lemon-grass respectively, were examined or the Department of Agriculture in Madras. The results indicated (1) that the so-called "white stemmed lemon-grass" is probably not lemon-grass but citronella, and (2) that the "insolubility" exhibited by some samples of Cochin lemon-grass oil is probably due to the distillation being carried too far. It was requested that a botanical specimen of the "white-stemmed" grass might be forwarded to the Imperial Institute for identification.

Oils and Oil-seeds.—Nahar seeds (*Mesua ferrea*) from Assam were found to yield about 46 per cent. of an oil suitable for soapmaking which would be worth £25 to £27 per ton in the United Kingdom (July 1913). The residual cake has a bitter flavour, and is believed to be poisonous, so that it could probably not be safely used as a feeding stuff; the manurial value of the cake is very small. Considered solely as a source of oil, however, the whole seeds should be worth £10 to £11 per ton, and the kernels £17 to £18 per ton, in the United Kingdom.

The results of further technical trials with samples of Raina seed (*Amoora Rohituka*) *and Panang kernels* (*Calophyllum Inophyllum*) were reported during the year to the Director of Agriculture in Bengal. These results confirmed the previous conclusions that both products yield oils suitable for soapmaking, and information was requested as to the possibility of their shipment to the United Kingdom in commercial quantities.

A small sample of the fruits of *Calophyllum tomentosum* from South Canara was also examined in order to determine the yield of oil from the kernels. The sound kernels contained 56·5 per cent. of moisture and 13·1 per cent. of oil, equal to a yield of 30·1 per cent. of oil from the dry kernels, which is less than the amount furnished by other species of Calophyllum. No definite conclusions can, however, be drawn from the results of the examination of this small sample of fruits which arrived in rather bad condition.

Drugs.—Two samples of the flower heads of *Artemisia maritima* were examined in order to determine whether the material could be utilised for the roduction of santonin. It was, however, found that neither of the samples contained santonin, and it was suggested that samples of the flower buds at an earlier stage of development should be collected and forwarded to the Imperial Institute for examination.

Burmese lacquer.—Further reports from firms and technical chemists who had been carrying out practical trials with "Thitsi" (Burmese lacquer) were received during the year, and were communicated to the Forest Economist at Dehra Dun. Certain of the firms expressed a desire to obtain trial consignments of the product, and the names of exporters of the material in Burma were furnished to them by the Imperial Institute.

Turpentine.—A report was made on a sample of the oleo-resin of *Pinus longifolia,* forwarded from the Imperial Forest Research Institute. The composition of the turpentine oil was determined and recommendations were made as to the best methods of distilling the oleo-resin in order to obtain an oil of good quality.

Miscellaneous.—In addition to the foregoing reports, information was furnished during the year to Indian Government Departments in connection with various technical and commercial matters, including the following:—

The marketing of sandalwood; the manufacture of tanning extracts in India; the medicinal use of Chaulmoogra oil; the chemistry of the roots of *Thalictrum foliolosum;* the detection of adulterants in beeswax; the cultivation of rice; the cultivation of soy beans; the cultivation of Madagascar beans.

A number of other miscellaneous enquiries relating to Indian matters, received from commercial firms and private individuals in India and in the United Kingdom, were also dealt with during the year, the subjects including foodstuffs, fibres, tanning materials, oil-seeds and oils, timbers and minerals.

A number of reports on Indian economic products were published during the year in the Bulletin of the Imperial Institute. The principal materials dealt with included the following:—

Para rubber, Para rubber seed cake, fish oils and guano, *Eruca sativa* seeds, *Calophyllum Inophyllum* seeds, *Mesua ferrea* seeds, lemon-grass oil, jute, *Malachra capitata* fibre, *Urena lobata* fibre, *Sida* fibre, monazite.

Various articles and notices relating to Indian economic products and their exploitation were also published during the year including the following:—

The Cultivation and Preparation of Rice, the Cultivation of Cotton, Mineral Production of India, the Tin Resources of India. Eucalyptus Cultivation in India, Timbers, Paper-making Materials.

List of materials received at the Imperial Institute from Government Officers in India during the year ended 30th June 1914.

Officer.	Material sent.	Number of samples.
Director-General of Commercial Intelligence, Calcutta.	Plantain fibre	1
Forest Economist, Dehra Dun	*Boswellia serrata* oil	2
Do. do.	*Boswellia serrata* resin	2
Do. do.	Deodar oil	1
Under Secretary to Government, Bombay	Castilloa rubber	2
Do. do.	Ak fibre, *Calotropis* sp.	7
Director of Agriculture, Bombay	Tobacco	1
Do. do.	Cotton	9
Director of Agriculture, Central Provinces.	Cotton	13
Director of Agriculture, Madras	Grass oils	2
Economic Botanist, Calcutta	*Calophyllum tomentosum* fruits	1
Do. do.	*Artemisia maritima*	2
Economic Botanist, Lyallpur	Barley	31
Conservator of Forests, Travancore	*Schleichera trijuga* oil	1
Deputy Conservator of Forests, Coorg	Sandalwood	1
Superintendent, Government Opium Factory, Ghazipur.	Morphine and codeine	22

List of Reports made by the Imperial Institute to Government Officers in India during the year ended 30th June 1914.

Officers to whom Reports were sent.	Subjects of Reports.
Director-General of Commercial Intelligence	Barley.
Director of the Botanical Survey	Roots of *Thalictrum foliolosum.*
Do. do.	*Calophyllum tomentosum* fruits.
Do. do.	*Artemisia maritima.*
Forest Economist, Dehra Dun	Thitsi (2 reports).
Forest Chemist, Dehra Dun	*Pinus longifolia* oleo-resin.
Under Secretary to Government, Bombay	Castilloa rubber.
Director of Agriculture, Bengal	Raina seed.
Do. do.	Panang kernels.
Do. do.	Nahar seed.
Director of Agriculture, Bombay	Compressed fodder (3 reports).
Do. do.	Tobacco.
Do. do.	Cotton.
Director of Agriculture, Burma	Madagascar beans.
Do. do.	Rangoon beans.
Do. do.	Peas.
Director of Agriculture, Central Provinces	Cotton.
Director of Agriculture, Madras	Grass oils.
Fibre Expert to Governments of Bengal and Assam.	Sida fibre.
Do. do.	*Urena lobata* fibre.
Economic Botanist, Lyallpur	Cotton.
Do. do.	Barley.
Conservator of Forests, Punjab	Bark of *Cryptostegia grandiflora.*
Deputy Conservator of Forests, Coorg	Sandalwood.
Agent to Government, Mysore	Beeswax.

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Departmental Publications.

I.—METEOROLOGICAL DEPARTMENT—

Government of India Office.

(1) The Indian Daily Weather Report and Chart.
(2) The Weekly Rainfall Summary.
(3) The Monthly Weather Review.
(4) The Annual Summary.
(5) The Rainfall of India.
(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.
(2) Monthly Rainfall Tables and Summaries of the chief features of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).
(2) Annual Summary.
(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(1) Monthly Summary } of Punjab weather.
(2) Annual Summary }

II.—GEOLOGICAL SURVEY.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I—XLI, including the larger papers on geological subjects.

Records, Vols. I—XLIV, including the shorter papers and Annual Reports from 1868 to 1914, sold in parts, price one rupee each.

Manual, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

III.—SURVEY OF INDIA.

(1) Annual General Report.
(2) Professional Papers.

N

IV.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.

(2) Records of the Botanical Survey, Vols. I—VII.

(3) Annual Report of the Industrial Section, Indian Museum.

(4) Annual Report of the Royal Botanic Garden, Calcutta.

(5) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in Agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British India by the Inspector-General of Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually.

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(5) The Indian Forester.—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal, published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) The Records of the Indian Museum, 8vo. Containing short papers on Indian zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalogue of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

CALCUTTA : PRINTED BY SUPDT. GOVT. PRINTING, INDIA, 8, HASTINGS STREET.